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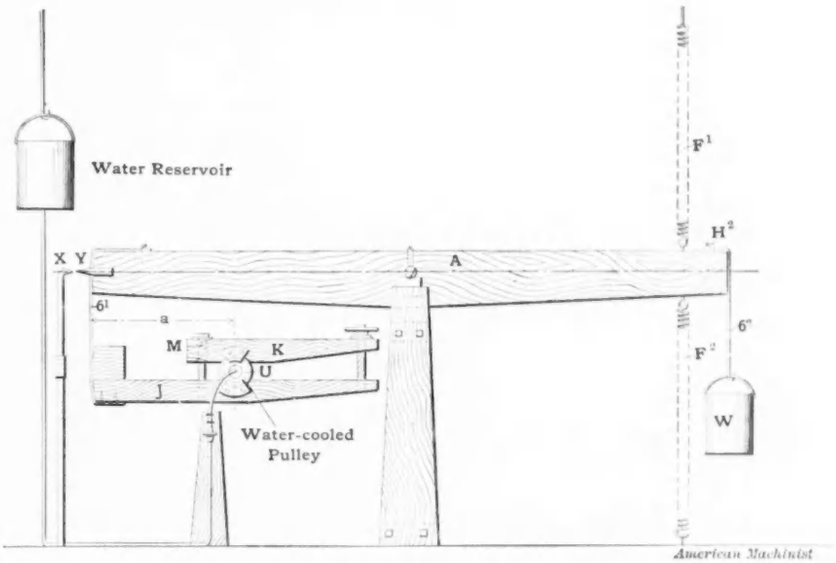
A Rough but Good Dynamometer.

BY H. W. ALDEN.

The accompanying engraving, partly diagrammatic and partly detail, shows a form of dynamometer for small-power motors up to 5 or 6 horse-power which is simple, cheap, difficult to get out of order and sufficiently accurate for all ordinary purposes where ultra-refinement is not required; although with care and skill some very remarkable results can be obtained even from this device.

The writer devised the apparatus primarily for testing a lot of electric motors, and as it was necessary to remove one and substitute another with the least possible delay and care in adjustment, the double-bar arrangement was used with a flexible strap 6^1 connecting the two. So long as this strap comes tangent to the circular ends of A and J it matters not whether the latter are exactly in the same vertical plane; indeed, they might, if desirable, be set at right angles. As the motors were high speed, the upper arm was made much longer than the lower to reduce angular vibration. Lateral vibration, due to inaccuracies in alignment of friction pulley, is eliminated by the flexible strap 6^1, so that the motion of A is very slight and very uniform.

Numerous forms of dash pot, hydraulic, oil and pneumatic were tried to reduce this vibration to a minimum, but were all too sluggish, and the springs F^1 and F^2 were finally introduced. They were made long and of large diameter, so that a slight angular motion of the arm A would but slightly increase the tension; in fact, 1 ounce on the strap 6^2 would separate the points X and Y noticeably. The springs perform a dual function; that of a dash pot and also of eliminating the necessity of balancing the arm A.



A ROUGH BUT GOOD DYNAMOMETER.

The general arrangement and operation are sufficiently plain from the diagram. The motors were tested at constant current consumption and the corresponding torque had to be obtained; hence the distance a from pulley center to strap center was made exactly 12 inches. It was found very convenient to use a pail of sand for W, as this permitted very fine variations of weight. The lower arm J, with its clamp K and attached parts, was very carefully balanced about its center when made.

The method of procedure was somewhat as follows: J was revolved slightly to the right, so as to remove all tension from 6^1, but still so as to permit its weight to hang on A. Pail W was removed and X brought exactly opposite Y. Everything being then in equilibrium, it is evident that if during the test these two points were kept exactly together, the springs exerted no effect upon the apparatus and the torque of the motor was represented by weight W, which was weighed after each run.

It may strike one at first that to keep these two points together would be very difficult; but I have seen the apparatus run for ten minutes with no attention whatever, and the points X and Y remain together, Y vibrating possibly 1-32 inch each side of X, just sufficient to show the dynamometer to be alive.

If any of the readers of the "American Machinist" are looking for a dynamometer easy to construct, operate and adjust the above can be confidently recommended to work satisfactorily.

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Testing the Accuracy of a Lathe Without Special Tools.

BY THEODORE H. MILLER.

When the new lathe comes into the shop, and sometimes in the case of an older one, it is desirable to know about how true it is, or, more accurately speaking, how its various parts line up one with another. Sometimes it is not merely desirable to test the lathe, but may be necessary, and perhaps if it were not considered to be, and usually made, such an expensive job, more lathes would be tested and made right when found out of true, and, likely, lots of time would be saved by the ability to turn out better work.

There are many ways to test lathes by the use of specially devised indicators and micrometers, and good straight edges and round and true arbors, and a good many articles have been published describing these tools and methods, which tools and methods are well enough for manufacturers of lathes, but not at all adapted to the needs of lathe users. What we want to consider now is how

to do the job without special tools or fixtures, and with just the ordinary stuff that is found kicking around the floor of almost any jobbing shop, and can easily be had in any other kind of a shop. At this date there are not many machine shops in this country which do not possess at least one ordinary 1-inch micrometer caliper, and this we will use in the testing of our lathe. Shops which do not possess such a caliper don't usually want to test lathes. This caliper is not absolutely necessary, however, and the job can be done without it, but may be done more quickly by using the caliper, which will not only show when a thing is out, but also just how much; which is exactly what we want to know.

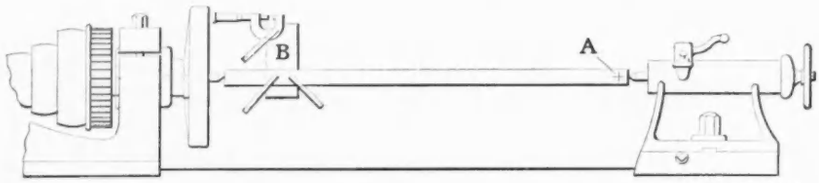

FIG. 1.—TESTING A LATHE FOR ALIGNMENT OF SPINDLE.

Perhaps it would be well to begin with the foot-stock and see if its spindle is parallel with the ways or shears of the bed, a necessary thing if good work is to be done.

For this test we will consider a lathe of about 16 inches swing and 6-foot bed. The first thing we will need is a piece of centered shaft or an arbor about 2 inches diameter, 4 feet long. It need not be either straight or round, but should be well centered and squared up true on the ends. Put this arbor on the centers with the foot stock spindle clear back. Make some kind of mark, as with chalk, near the tail center end of the arbor, as at *A*, Fig. 1.

In the tool-post of the lathe mount the 1-inch micrometer caliper, as shown in Fig. 2, with the thimble end to the work. This may be done by bending a tool shank or piece of iron, as at *A*, Fig. 2, and the caliper can be held in place upon it by almost any kind of a clamp that comes handy, such as *B*. By moving the carriage and tool block, bring the thimble end of the caliper near the mark *A* on the arbor in Fig. 1, open the caliper to bring the thimble in contact with the arbor—though it would be a good plan perhaps to interpose a piece of paper between the caliper and arbor, that may be pulled between them in order to always get about the same contact. When the proper contact is made note the reading and back off the caliper by turning the thimble, but do not move the tool block. Now loosen the foot-stock and run out the spindle to near the end of the screw and clamp again; then measure again just as before and if the two readings agree the tail spindle is in line sidewise. The caliper should now be changed to the position shown in Fig. 3, and the two measurements taken on top of the arbor the same as were taken at the side. The mark *A* is now turned upward, since we are assuming that the arbor is not true, and this enables us to measure from the same spot for each measurement of a given test.

Perhaps the thing to do next is to test the truth of the live center. Measure to the spot on the arbor near the live center, either from the side or top, then turn the spindle, say quarter way around, holding the arbor in the original position, and measure again; repeat this about four times and if all the readings agree the center is about right.

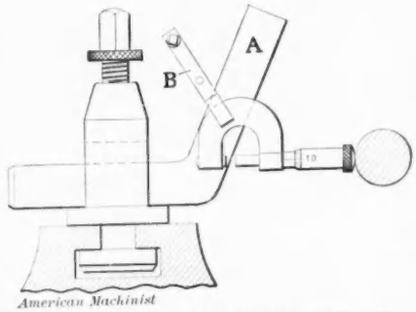

FIG. 2.—TESTING ALIGNMENT OF CENTERS AND OF TAIL SPINDLE.

A way to test the center hole is to put the center in place, being careful to have it clean, and turn or grind it true; then remove and put back again turned half way around from the first position, when the error of the hole, if there be any, will be doubled and may be more readily measured. Sometimes the front and back end of this hole are not true with each other, and in this case about the only way to test or find out how much it is out is to fit a piece to the hole, having a straight end which, in this case, should be both true with the taper shank and straight. By putting this in place and measuring with the caliper held as in Fig. 2, at both ends and by turning the spindle, it may be seen at once whether the hole is in its proper place.

Next we will line up the head and tail centers. Put the caliper in position, Fig. 2, and measure to the marked spot on the arbor, then turn the arbor end for end and run the carriage along without changing the cross slide and measure again. If the two readings agree, all right; if not, adjust the foot stock until they do agree, when the centers will be in line with the shears.

To find if the centers are the same hight, place the caliper in position, Fig. 3, and measure near each center, by reversing the arbor as before.

To find whether the live spindle is in line with the centers and shears, clamp a parallel strip or rough piece of bar iron, such as *B*, Fig. 1, on the arbor near its end and on that clamp the caliper, as shown in Fig. 1. Then with the largest face plate on the spindle and a mark on the plate (as it is not assumed to run true at all) measure to the plate with the mark at the top and again at the bottom, by turning both the spindle and arbor. Any difference in the readings will show at once which way the spindle inclines vertically. Repeat this operation by measuring both at the front and back, by which the alignment laterally with the shears may be noted.

To find whether the cross slide is at right angles with the spindle and shears: If a good straight-edge be at hand, one way is to take a cut over the large face plate and apply the straight-edge, when, if the spindle is in line with the shears, and the plate is flat, the cross slide will be proven to be at right angles. But then perhaps it is not convenient to take a cut over the plate, and so we will consider a way of doing it without any cutting at all. Mount the caliper on a tool shank, as shown in plan by Fig. 4, with the thimble pointing to the face plate. Most tool blocks will not go far back of the center, so the caliper should be mounted somewhat in front of the tool-post, as shown, so that it may travel an equal distance each side of the center, and should go as far as possible from it in each direction. Measure to a mark on the face plate, as shown in full lines at *A*, then back off the thimble and move the tool block and caliper to the position shown in the dotted lines at *B*. Turn the spindle to bring the mark on the plate to that side and measure again, and if the two readings agree the cross slide is at right angles with the spindle and also with the shears if the spindle is

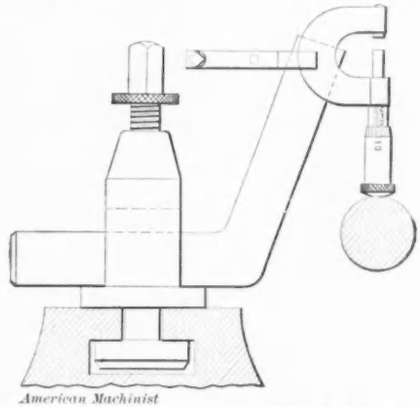

FIG. 3.—TESTING VERTICAL ALIGNMENT OF CENTERS AND OF TAIL SPINDLE.

properly in line; if not, its position may easily be found by noting the alignment of the spindle, as shown by the preceding test.

On some accounts it might be preferable to make this last-named test with the micrometer arranged as in Fig. 1, except that the piece *B* should then be nearer the middle of the length of the arbor. A piece of any convenient form can then be held in the tool-post and brought into contact position with the micrometer, first in front and then at the back of the arbor, rotating the latter upon the centers to bring the micrometer into position and moving the cross slide by the screw. This method has the advantage of eliminating any error that might arise from end motion of the spindle when rotating it; but it is to be observed that it shows only whether the cross slide is square with the line of centers, and nothing more than that. If, however, the centers have been previously lined up with the shears by the method described, then this last-named test also shows whether the cross slide is square with the shears or not. And if the spindle has been previously lined up with the line of centers as previously described, then this last-named test shows also whether or not the cross slide is square with the spindle.

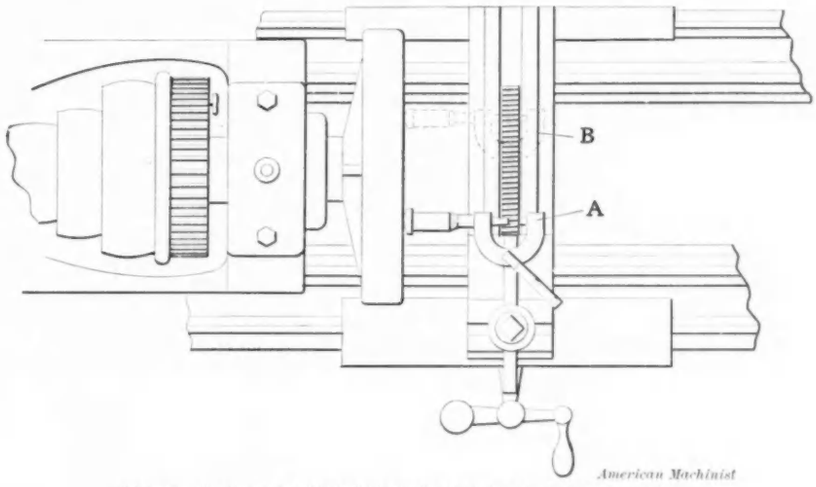

FIG. 4.—TESTING THE CROSS-SLIDE FOR SQUARENESS.

It will be seen that the micrometer caliper is not absolutely necessary for any of these tests, as by the use of a common cap screw, fitted rather snugly in the piece held in the tool-post and on the arbor, all the tests may be made, and perhaps just as accurately as with the caliper, but with the disadvantage of not indicating just how much the various points are out of position.

This method of testing a lathe is not given with the belief that it is the very best that can be used, but it is a very cheap and simple method, covering most of the points desirable to be tested, and at a cost that will not prohibit its frequent use.

The use of the end of the thimble of the micrometer caliper is not a new idea at all, though perhaps it is as applied in this way and for this purpose. One of the very early calipers, made in France and illustrated in the "American Machinist" some years ago, had a hardened contact point on the end of the thimble and another extended from the ordinary anvil, and the caliper was intended for internal measurements as well as for the ordinary outside work.

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Southern Competition in Cotton Manufacturing.

A novel and strange peculiarity of the present labor troubles in New England deserves attention. The striking operatives are mostly foreigners, and the "cheap labor" which has reduced their wages is that of native-born citizens, and of white ones at that, and not of negroes, as seems to be the general impression. Fall River, for example, has a population of about 100,000. Of these 20,000 are English, 35,000 are French Canadians and 15,000 are Portuguese. The remainder are of American birth, but very few of them work in the mills, the majority of this class preferring to engage in business for themselves. The Southern factory hands are exactly the sort of people that filled the Northern mills thirty years ago. They are gathered from surrounding farms, and lack neither intelligence nor strength, though, of course, their skill in the management of delicate machinery still leaves much to be desired. Wages in the South are less by about 25 per cent. than in the North, but the cost of living is also less to about the same extent, so there is no particular difference in the material condition of the operatives in the two sections. Not all the advantages are on the side of the Southern mills. Those of New England are run with more attention to minor details, and therefore with less waste of material and energy. They also have better market facilities, especially for goods of the finer grade, and it is probably for this reason that Southern competition has up to the present time been felt chiefly in coarse and therefore cheap fabrics. Already organizations of self-protection in the matters of hours and wages are forming among the Southern mill hands, and there is no reason to think that their employers will profit indefinitely by the more lenient laws under which the establishment of their industry in its new field was fostered.—"New York Times."

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Definitions of Annealing.

The definition of annealing, as generally given in the dictionaries and elsewhere, seems to need correction. A recent writer on the annealing of glass says: "Annealing means to heat a substance and then allow it to cool gradually." Webster says to anneal is "to heat nearly to fluidity and then cool slowly for the purpose of rendering less brittle." The Century dictionary gives "to treat by heating and gradually cooling so as to toughen and remove brittleness." The Century tries it again, and says annealing is "the process or art of treating substances by means of heat, so as to remove their brittleness and at the same time render them tough and more or less elastic. In general, those results are obtained by heating to a high temperature and then cooling very gradually." As all mechanics know, the process of annealing copper or brass is precisely the reverse of that above indicated, as, to anneal them, they are first heated and then cooled with all possible suddenness. Even steel is not usually supposed to be made "tough and more elastic" by annealing. The mechanic's idea of annealing is simply the softening of metal by heating and subsequently cooling it, the cooling in some cases being as slow and in other cases as quick as possible.

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Improving the Gas Engine.

The possibilities of increased economy in the gas or the oil engine have been found to lie in the same direction as with the steam engine, the use of higher pressures. In the Diesel motor the air which is used is first compressed to thirty or forty atmospheres, the fuel to be used is injected after the air compression, and the combustion is accomplished more slowly than has heretofore been done. An excess of air is provided and very complete combustion is secured. An efficiency up to 50 per cent. above that of previous types is claimed, and for equal cylinder capacity a higher mean effective pressure and a greater total power are developed. The engine seems to be more complicated, and must be built heavier than those with which we are now familiar.

The Analysis of Air Compressor Indicator Diagrams.

BY F. A. HALSEY.

A Western correspondent sends us the combined indicator diagrams from a Rand cross compound air compressor, shown in Fig. 1, with data from a test as follows:

Size of air cylinder, L. P..... 14x16
Size of air cylinder, H. P..... 7½x16
Size of steam cylinder..... 10x16
Steam pressure..... 70 lbs.
Air pressure.....110 lbs.
Revolutions per minute..... 35
Temperature of cooling water... 55° Fr.
Temperature of discharge water from cylinder jackets and inter-cooler..... 62° Fr.
Temperature of engine room.....80° Fr.
Temperature of cold air inlet.... 70° Fr.
Temperature of discharge air from low-pressure cylinder...170° Fr.
Temperature of air entering high-pressure cylinder..... 65° Fr.
Temperature of discharge air from high-pressure cylinder...135° Fr.

Average from a number of indicator cards.

Two steam cylinders, 10x16 inch initial pressure, 54 lbs.; M. E. P., 40.4 lbs.; I. H. P., 17.95.
Low-pressure air cylinder, 14 x 16 inch, M. E. P., 21.3 lbs.; I. H. P., 9.24.
High-pressure air cylinder, 7½ x 16 inch, M. E. P., 46.0 lbs.; I. H. P., 5.75.
Both air cylinders (high pressure reduced to low), M. E. P., 34.5 lbs.; I. H. P., 14.99.
Friction of compressor, 16.4 per cent.; I. H. P., 2.96.
Steam per I. H. P. per hour, 29.33 lbs.
Cubic feet of free air compressed to 110 lbs. pressure per pound of steam at 54 lbs. initial pressure, 10.6.
Efficiency of air cylinders, 91.5 per cent.

With this diagram and these data our correspondent asks the following questions:

1. Please explain the formula for the adiabatic compression of air.
2. How is the volume for a given pressure found?
3. How is the index of the actual indicator curve found?
4. Do the same methods apply to both cylinders of a compound compressor?
5. How is the mean effective pressure due to adiabatic compression found?

These inquiries relate to problems which, in the widening use of compressed air, are of general interest and justify more space than can be given to them in the column of "Questions and Answers," and on that account they are taken up here.

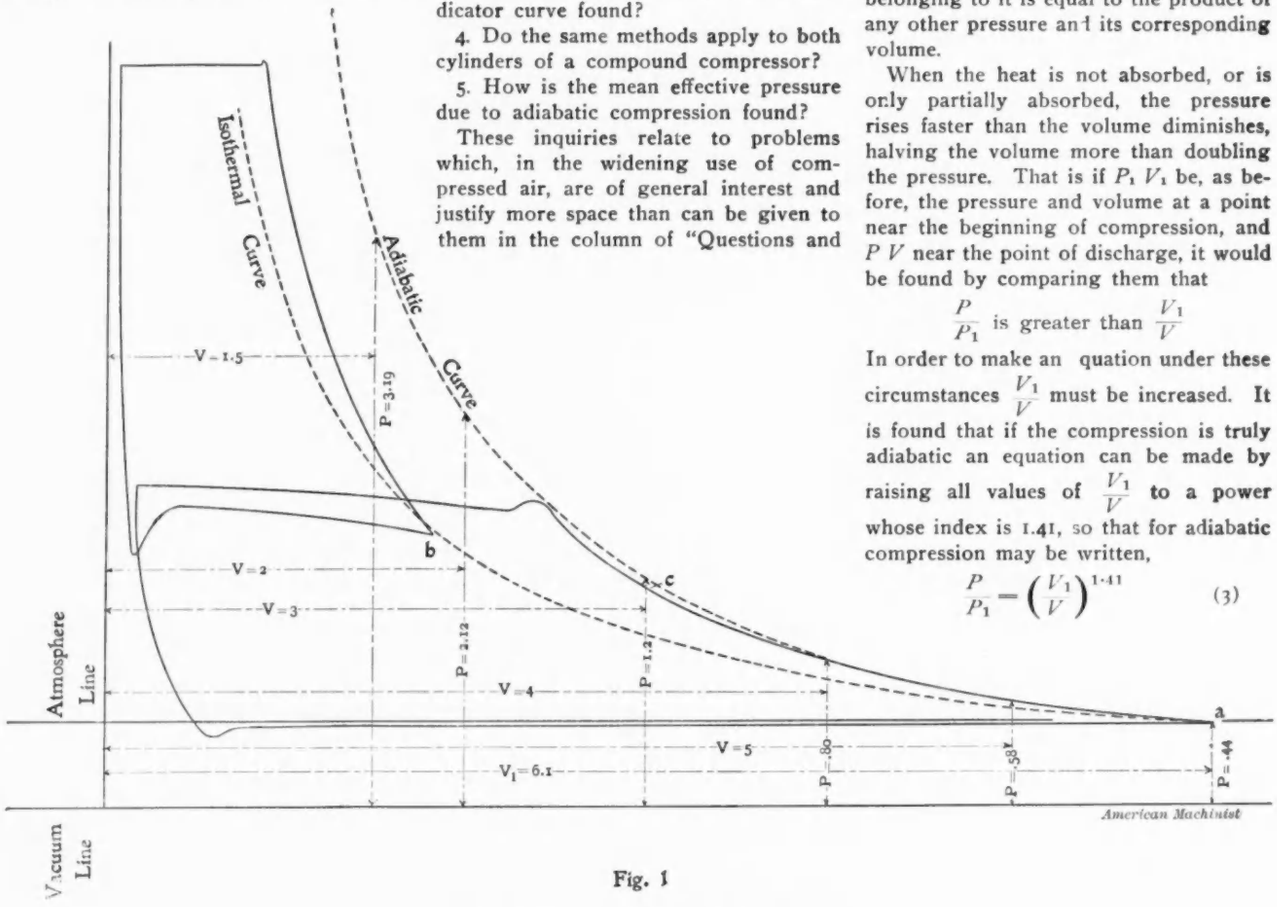

Fig. 1

COMBINED AIR COMPRESSOR CARDS.

THE ADIABATIC CURVE.

If the heat of compression could be entirely absorbed as developed, the compression would be in accordance with Marriott's law, which says that the pressures and volumes are inversely proportional, or that halving the volume doubles the pressure, and so for other volumes and pressures. This is expressed by the equation

$$\frac{P}{P_1} = \frac{V_1}{V} \qquad (1)$$

in which P and V are some corresponding pressure and volume, and P_1 V_1 are some other corresponding pressure and volume. If, for example, P_1 V_1 are the pressure and volume at the beginning of compression and P V at the half stroke, obviously

$$\frac{P}{P_1} = 2 \text{ and } \frac{V_1}{V} = 2$$

Similarly, if P V are pressure and volume at one-third stroke,

$$\frac{P}{P_1} = 3 \text{ and } \frac{V_1}{V} = 3$$

and so for any other points which may be compared. Equation (1) can obviously be made to read

$$P\ V = P_1\ V_1 \qquad (2)$$

which is equivalent to saying that the product of any pressure by the volume belonging to it is equal to the product of any other pressure and its corresponding volume.

When the heat is not absorbed, or is only partially absorbed, the pressure rises faster than the volume diminishes, halving the volume more than doubling the pressure. That is if P_1 V_1 be, as before, the pressure and volume at a point near the beginning of compression, and P V near the point of discharge, it would be found by comparing them that

$$\frac{P}{P_1} \text{ is greater than } \frac{V_1}{V}$$

In order to make an quation under these circumstances $\frac{V_1}{V}$ must be increased. It is found that if the compression is truly adiabatic an equation can be made by raising all values of $\frac{V_1}{V}$ to a power whose index is 1.41, so that for adiabatic compression may be written,

$$\frac{P}{P_1} = \left(\frac{V_1}{V}\right)^{1.41} \qquad (3)$$

If part of the heat is absorbed, the value of this index is less, growing smaller and smaller as more heat is absorbed, until, if it be all absorbed, the 1.41 becomes 1, and equation (3) becomes the same as (1).

Equation (3) may easily be made to read

$$P\ V^{1.41} = P_1\ V_1^{1.41} \qquad (4)$$

to correspond with (2), and this equation (4) is the working general equation of the adiabatic curve, and from it the curve may be laid out as with the equation of

any other curve. To do this it is only necessary to measure P_1 and V_1 at the beginning of compression, and then assume various smaller values for V and calculate the corresponding values of P. The fractional exponent, 1.41, however, compels the use of logarithms, as it is not possible to raise a number to the 1.41 power by arithmetic. P_1 and V_1 might be measured at any other point of the curve if desired, the result being a curve running through the point selected, but the only one of these many possible curves which possesses much interest or importance in studying compression is one running through the point where compression begins. In the case of an engine driven by air, the curve of interest would be the one running through the point of cut-off. Taking point *a*, then, of Fig. 1, at the beginning of compression a scale of inches and tenths* shows that

$$P_1 = .44$$
$$V_1 = 6.1$$

from which the value of $P_1 V_1^{1.41}$ in (4) is to be determined.

log. 6.1 = .78533
multiply by 1.41
product 1.10731

which is the log. of $12.83 = 6.1^{1.41}$

giving $P_1 V_1^{1.41} = .44 \times 12.83 = 5.645$

This value of $P_1 V_1^{1.41}$ being now substituted in (4) gives

$$P V^{1.41} = 5.675 \qquad (5)$$

the equation of the curve in this case.

Proceeding now to the plotting of the curve, assume a value 5 for V giving

log. 5 = .69897
multiply by 1.41
product .98554

which is the log. of $9.673 = 5^{1.41} = V^{1.41}$ in (5). Substituting 9.673 for $V^{1.41}$ in (5) gives:

$$P \times 9.673 = 5.645$$

or

$$P = \frac{5.645}{9.673} = .58$$

the value of P to go with value 5 for V. Assuming other convenient values for V, and calculating the corresponding values of P as above, gives:

Assumed Values of V.	Calculated Values of $V^{1.41}$	Corresponding Values of P.
5	9.67	.58
4	7.06	.80
3	4.71	1.2
2	2.66	2.12
1½	1.77	3.19

Laying off these volumes in Fig. 1, drawing the vertical lines, and on them laying down the pressures, gives points on the curve as shown, through which the dotted curve has been drawn.

The procedure for the high-pressure cylinder is precisely the same, the pressure and volume at *b* being taken as the starting point, as *a* was for the low pressure card. Obviously the process might have been reversed, if desired, the pressures being assumed and the volumes calculated.

The labor of calculating the points of the curve may be lessened by the use of the diagram, Fig. 2, which gives the relative increase of pressure for the reduction of volume as the compression goes on. To use the diagram the indicator card should be divided into tenths and half-tenths, as this diagram is divided. Then, taking the absolute pressure at the beginning of compression, the product of this pressure by the multiplier at the left of each ordinate of the diagram will give the pressure due to the adiabatic curve at the corresponding ordinate of the indicator card. The diagram is applicable to high and low pressure cards alike, the proper initial absolute pressure being taken, of course. For the low-pressure cylinder the initial pressure shown by the indicator card should be used, and not the full atmospheric pressure, as, in the nature of the case, there is bound to be some loss of pressure in the cylinder due to the friction of the air valves and passages, and to the putting of the air in motion. The assumption of full atmospheric pressure results in a curve which is too high for the truth, and gives the compressor credit for a degree of cooling to which it is not entitled. For compression at the sea level, when exact data are not at hand, 14 pounds actual initial pressure may be assumed, and for this pressure the multiplications have been made and entered on the right side of the vertical lines of the diagram, from which the pressures at the various ordinates may be read directly for that initial pressure.

It will be seen in the card submitted by our correspondent that the compression curve of the low-pressure cylinder follows the adiabatic curve quite closely, and in cards which have come under my observation, from fair sized compressors, in good condition, and at working speeds, this is usually the case. Small compressors have, of course, a greater ratio of cylinder surface to volume than large ones, giving a better opportunity for cooling, and by slowing down the speed a similar improvement of conditions can be brought about. Again, a leaky piston, by permitting the air to escape past it, will cause the pressure to rise before it more slowly than it should, and a distinctly bad condition of things may be, and often has been, interpreted as the very contrary, the low curve due to a leaky piston being interpreted to be due to superior cooling. As stated above, cards from compressors in good condition and under working speeds usually follow the adiabatic line closely, and, for the reasons cited, I always look with suspicion on those which do not, or apparently do not closely follow the theoretical curve.

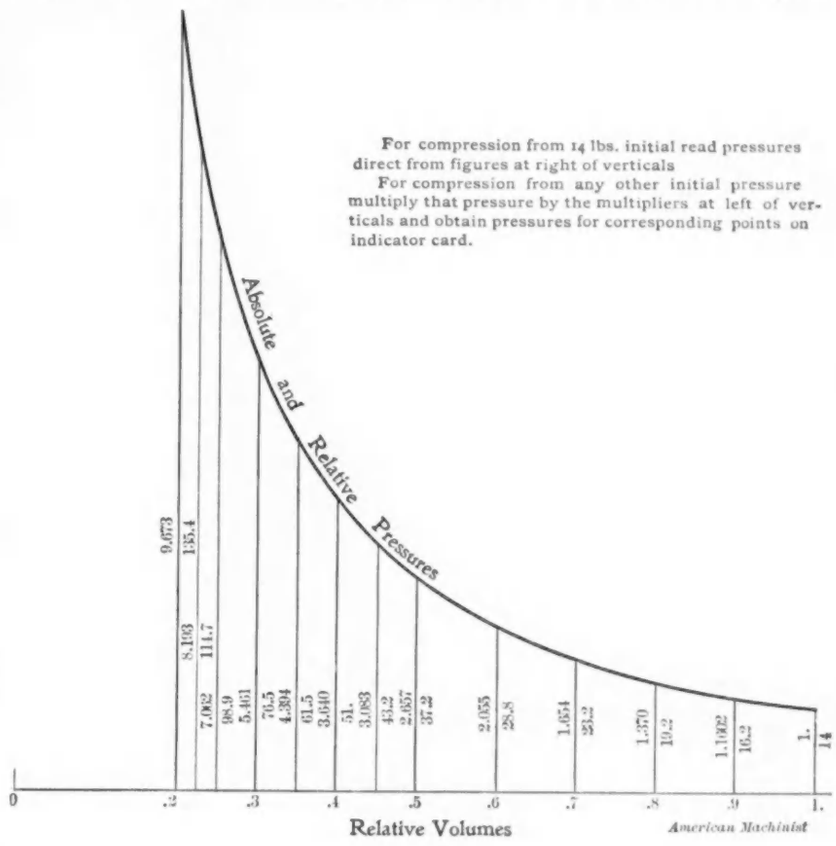

Fig. 2

DIAGRAM OF ORDINATES OF THE ADIABATIC CURVE.

* The scale employed for this purpose is immaterial. A scale of inches divided into tenths is convenient and is here used.

Hints on the Winding of Magnet Coils.

BY WILLIAM BAXTER, JR.

Every man engaged in manual labor of any kind fully realizes all the fine points of his calling, and not a few vastly overestimate the special adaptability and experience required to attain the highest proficiency in their particular lines. Those who make a living by winding magnet coils are no exception to the rule; but while many of them overestimate the difficulties involved in the operation, it is doubtful whether they go as far beyond the mark as those who have never essayed work of this kind fall short of it. From an examination of a finished coil, as well as from watching the process of winding, one would naturally come to the conclusion that the operation is so simple that anyone possessed of an average amount of intelligence could do it perfectly the first time. When the first attempt is made, however, this notion is entirely dispelled, and then one begins to realize that there is a certain amount of skill required that can only be attained by practice. If the novice starts with a full knowledge of the points to guard against, in order to avoid defective work, he will soon become as expert as those who have been engaged in that line for years, but if he has to find out these points by the hard knocks of experience it will require several times as long an apprenticeship before proficiency is attained.

Large wire is easier to wind so as to produce a neat appearance than small; but, on the other hand, there is less danger of destroying the insulation when the wire is small. A wire 100th of an inch in diameter will measure sixteen to eighteen thousandths over the insulation; but a wire 1-10th of an inch in diameter will only measure about eleven hundredths over the insulation. With the fine wire the insulation occupies a space nearly equal to the diameter, but with the larger size the ratio is about 10 to 1. As the metal is not so compressible as the insulating material, there is not as much "give" in a coil of thick wire as in one of thin. As the large wire is stiffer it has to be wound under a greater tension; therefore there is more liability of the insulation being pressed out of the space between adjoining wires. With fine wire, as the tension must necessarily be light, there is little danger of cutting through the insulation; but as the whole body of wire is in a more spongy state there is greater liability of the turns in one layer crowding down between the wires of the under layer, and thus producing an uneven surface. As the covering of large wire, which is generally cotton thread, is so much softer than copper it might be supposed that there would be great difficulty in preventing the cutting of it where the wires press upon each other, especially as the covering is so thin; but experience shows that there is no such danger, so long as the only strain is the tension required to wind the wire snugly. The greatest danger comes from attempts to crowd too many turns in a layer, as illustrated in Fig. 1. In this figure the outline represents the space within which the wire

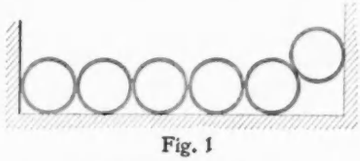

Fig. 1

Fig. 2.

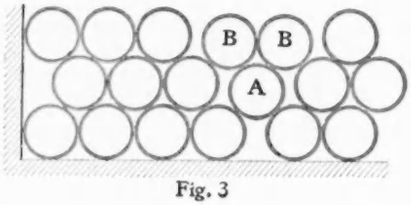

Fig. 3

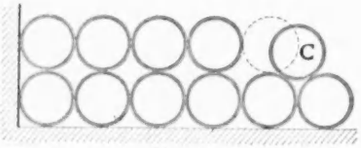

Fig. 4

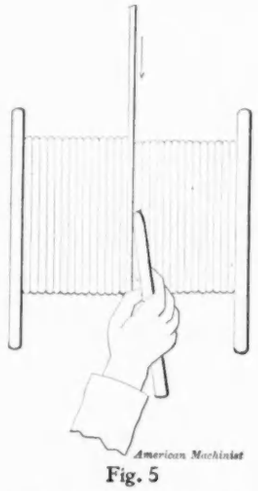

Fig. 5

WINDING MAGNET COILS.

is confined. The wire winds around the coil like the thread of a screw, and therefore at the end the space for the last turn becomes less and less, until it is so narrow that the wire cannot drop into it, but it can be forced into the space as the insulation is yielding, and as in being forced in it acts like a wedge the side pressure against the wires may become very great long before the wire offers any decided resistance to being forced down. The result of this crowding, if carried far enough, would be to cut the insulation on the sides of the wire, as shown in Fig. 2. If through fear of injuring the insulation in this way the wire is not forced in tight enough the result will be that when the second layer is wound it will at one turn or another spread the wires in the first layer, and thus drop below the proper level, as shown at *A*, in Fig. 3. If this happens the depression in the surface of the coil will increase in width with each succeeding layer, and become a series of undulations after a number of layers have been wound. In the third layer the wires *B B* would drop into the spaces on each side of *A* and, as in the fourth layer *B B*, could be forced to one side or the other, or be separated from each other, the form of the depression in the fifth layer would become undulating, instead of an even depression. If the wires in one layer form a right-hand screw in the next they will form a left-hand screw; therefore along a portion of the turn the wires will not drop into the spaces of the under layer, as shown in Fig. 3, but will be as in Fig. 4. If the under layer is wound very close the turns on the top layer will gain on those of the under one, and before many turns have been wound the wire will drop in the space ahead of it, as shown at *C*.

From the foregoing it is evident that if the wire is wound too close the results will not be good, as the insulation may be cut, as in Fig. 2, and, furthermore, there will be difficulty in keeping the wires of the next layer from dropping into the space ahead of them in that part of the turn where they ride on top of the wires of the lower layer, as shown in Fig. 4. If the winding is not close enough the wires of the next layer will crowd into the spaces between the turns, as shown in Fig. 3. The only way to find out just how compact the winding should be is by practical experience; but when we know what the effects will be if the turns are pressed together too tight, or are too far apart, the ability to judge as to the proper spacing is sooner acquired. If the wire is of large size we can calculate approximately from its diameter and the length of the coil the number of turns that should be wound in a layer; but such calculations, when the wire is small, will be of little service, unless they can be checked by comparison with well-wound coils of about the same size wire, or by the knowledge obtained in a practical way. As an illustration, suppose we have a coil 4 inches long and desire to wind it with No. 10 B. & S. wire; as this gage is about ten hundredths of an inch in diameter and eleven hundredths over the insulation we can see at once that of the bare wire 40 turns would be sufficient to fill the space, and of the insulated wire about 36. If we undertook to force 37 turns in the layer the insulation

would be compressed to about three-quarters of its thickness; if 38 turns were forced in the insulation would be compressed 50 per cent. As the compression is liable to cause the insulation to give way at one point sooner than at anther, with 38 turns some of the wires would very likely come in contact; but this might not occur with 37 turns. The greatest trouble to be apprehended from forcing 37 turns in the layer would be that the next layer could not be wound equally as close, and the trouble of Fig. 4 would be experienced. If instead of No. 10 wire we had No. 26, which is about sixteen thousandths of an inch diameter and measures about twenty-two thousandths over the insulation, we would find that of the bare wire it would require about 250 turns to fill the space, and of the insulated about 180, providing the insulation were not compressed. The wire would fill up about 2⅞ inches and the remaining 1⅛ inch would be filled by the insulation. How much this 1⅛ inch of insulation should be compressed so as to prevent the wires in the next turn from crowding down into it we can only guess at, if we have not found out by actual trial. Therefore, a calculation as to the number of turns in the layer with fine wire will be of little assistance, unless we know to what extent the insulation must be compressed.

It is important that the first layer be wound as perfectly as possible, as it forms a guide for the succeeding ones If this layer is properly spaced there will be little difficulty in winding the others evenly.

Even when the spacing is accurate the trouble shown in Fig. 4 will be experienced, unless the wire is pressed back continually, as owing to the fact that there is not as much end pressure on the layer that is being wound as on those under it, the wire will persist in gaining on the turns of the under layer. With small wire, from about No. 15 up, the turns can be kept in place by using a stick of hard fiber or cherry in the manner indicated in Fig. 5; but with larger wire it is necessary to drive the turns back continually with a block of wood and a mallet; but these must be used gently, in a manner in keeping with the strength of the insulation.

With very fine wire it is difficult to wind a coil smoothly, if it is of any length and has many layers. If a defect occurs in one layer it becomes worse in each succeeding one, and after a few layers becomes so bad that it is necessary to even up the coil with stiff paper, so that the uniformity may be restored in the next layer. This procedure is objectionable, and every effort should be made to avoid it. The only way to accomplish this is to not let any defective parts pass, as is too often done upon the supposition that in the next layer the unevenness can be smoothed over; but when that layer is reached it is found that the smoothing-up process does not work as well as was expected. In winding small wire it is advantageous to shellac the first layer, and every layer after that, that is evenly wound, as these serve as foundations for the wire wound on top of them and thus assist in keeping the coil smooth.

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American Exports of Machinery in 1897.

From the official summary of exports from this country for the month of December, 1897, which has recently been issued, it appears that the total exports of machinery during the last year amounted to $30,171,150. This stands in contrast with $25,769,790 for the year 1896, and shows an increase of 17 per cent.

This large expansion in value is the more significant because 1896 was itself a year of such phenomenal foreign trade that a shrinkage following it seemed not unlikely. In the line of machine tools there were reasons for believing that a maximum had been reached in 1896, or the first part of 1897, and that the progress of the latter year would show a decline. It appeared to be a question of a short time only how soon Europe would be near its saturation point and orders become less frequent. In fact, the spring of 1896 showed some indications that such was the case. From the present viewpoint, however, it appears that the American foreign trade in machine tools has held its own well in 1897, and not improbably has amounted to more in the last year than ever before. But this question can never with certainty be determined because our Government has only lately recognized the great importance of metal-working machinery as a factor of commerce, and did not, therefore, begin their separate classification until the first of the present fiscal year, which commenced with July, 1897.

The exports of metal-working machinery for the half year from July to December, 1897, inclusive, were $2,040,888. At the same rate the amount for the year would be about $4,000,000. This is a large sum, but the total for all kinds of machinery is so much larger that we cannot draw from it any reliable deductions as to the increase or decrease in this particular line. The entire list of machinery exported includes: Electrical, metal-working, printing presses, typewriters, pumps, shoe machinery, sewing machines, fire, stationary and locomotive engines and "all other," the "all other" comprising more than half the total. Some of these have been separately listed during the entire year, and longer. Among them stationary engines show a noteworthy increase from $265,882 in 1896 to $359,698 in 1897. This may be due in part for the large orders for foreign electric railway engines taken by a Western concern in this country, and we imagine that the valuation contracted for was greater than that actually shipped by the end of the year, so that there is enough left over to give the figures of 1898 a good start. The value of locomotives exported in 1897 was $3,055,842 against $2,980,278 in 1896, which is not much of an increase, but very satisfactory, if it be remembered how good a year for locomotive exports 1896 was. The number of locomotives, by actual count, increased more than did the value, being 348 in 1897 against 312 in 1898. Therefore the average export price of a locomotive in 1897 was $8,781, while in 1896 it was $9,552. This cheapening may be due to the engines shipped last year having been smaller or of an inferior grade, or it may be because competition in the export field has been growing more keen. It has already been reported that close figures have been made upon locomotives for export.

In the article upon British exports for 1897, published in the "American Machinist" February 3, locomotive shipments from that country were shown to have been $5,062,935 (assuming the value of a pound to be $5) in 1897, against $5,389,115 in 1896. Although with them, as with us, the statements for the two years compared show but a trifling difference, that little is for them a decrease, while for us it is an increase.

The total British exports of machinery advanced to $24,627,395 in 1897 from $21,572,435 in 1896. This was an increase of 14 per cent. against ours of 17 per cent. They have done remarkably well considering their engineers' strike, but fortunately our improvement is more rapid than theirs. It will be noticed also that our total is several millions dollars ahead of theirs in actual amount, although this comparison may be misleading because the term "machinery" is a flexible one, and it is not certain that the English statisticians include under it all that ours do.

It should also be remarked that the changes which have been made in American export statistics by removing certain lines of goods from the miscellaneous list to a class of their own create some confusion, and we cannot guarantee that our computation of the grand total of machinery exports from the several subtotals is free from the result of latent omissions or duplications. However, it appears to be correct, though we wish that the Department at Washington had itself added up the figures, as it formerly did.

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When it is necessary to stir brass or bronze in the crucible don't do it with an iron rod. Graphite stirrers are now furnished for the purpose, and are highly spoken of by those who use them. The iron from the rod gets into the brass.

The Flow of Water in Pipes.

BY E. SHERMAN GOULD.

A great many of the problems involved in engineering, although based on deep mathematical principles, have been reduced to such simple formulas that they can be, and are, currently used by persons who, from lack of special study, would find great difficulty in following and understanding the processes by which they were developed.

Many subjects, such, for instance, as the strength of beams, have been reduced to convenient form for easy solution, but when we come to questions of hydraulics the case is different. About all that the average mechanic knows instinctively concerning the motion of fluids is that water runs down hill. This is certainly something, particularly when we reflect that the corollary, or rather lemma, to this proposition, namely, that water will *only* run down hill, seems to be occasionally lost sight of even to-day. But suppose a mill owner should want to know what size pipe to use to convey so many gallons of water per hour from a higher to a lower level, through a certain length of pipe line, in what perplexity does he find himself! Indeed, so confused may be the mind of even smart mechanics on this subject that the question is sometimes asked, how many gallons of water per minute will a 4-inch pipe carry? Possibly, in order to furnish all the necessary data, and so satisfy the exactions of "theorists," it may be added, "under ordinary pressure." If the handbooks are consulted it is generally found necessary to read through several pages of explanation which lead up to a complicated formula requiring still further study to render it applicable to the given case.

The reason for all this is very plain. Scientific hydraulics are only now, in these latter days, being put into the same practical shape that "strains in girders" already enjoy. When once mathematical refinements and hair-splitting coefficients are swept aside and practical working data alone dealt with the one becomes nearly as simple as the other.

In the first place it is necessary to draw a distinction between long and short pipes. By "long pipes," in practical hydraulics, is meant pipes of 1,000 diameters and upward in length. That is to say, a 12-inch pipe is classed as a long or a short pipe according as it is or is not 1,000 feet and upward in length.

In this paper long pipes, as above defined, will be alone considered, first because the formulas are simpler, and secondly because they embrace the larger number of important practical cases. Also cast-iron "hub and spigot" pipes will be understood as those in question throughout.

In studying the subject of the flow of water through such pipes experimentally (the only way possessing any value whatever), it was soon found that the character of the inside of the pipe, *i. e.*, its relative smoothness or roughness, exercised a surprising influence upon the velocity of flow, and consequently the volume discharged through it. For instance, if a very smooth cast-iron pipe of a certain diameter furnished a certain discharge, a very rough pipe, under the same conditions, will require a diameter about 15 per cent. greater in order to deliver the same amount of water in the same time. These two figures, 1 and 1.15, being the limiting values of smoothness and roughness expressed in terms of the diameter, it is evident that there will be an indefinite number of intermediate percentages depending upon the greater or less degree of smoothness of the interior surface of the pipe. This confusing element, while it may give the mathematician pause, does not trouble the practical hydraulician in the least. He cares nothing for intermediate values. Adopting, unconsciously, a process of the higher mathematics, he "passes to the limit," and recognizing the fact that from one cause or another his pipe, no matter in how perfect a condition it may have been when first laid, is liable to get foul in the course of time, and having a fixed approximate limit to the degree of foulness and consequent roughness which in practice it is likely to reach, he is not long in making up his mind to adopt at the start a diameter which it is probable will be required later on.

Experimental research showed also that the diameter of the pipe had an appreciable influence upon the velocity of the flow of water through it. That is to say, if there were two pipes exactly alike as regards interior surface, but one had a greater diameter than the other, the velocity of flow through the one of greater diameter would be more rapid than that through the one of smaller diameter, all other things being equal. Here was another confusing element, scientifically speaking, but the practical man perceiving from the table of coefficients furnished by the experimenters that these differences were not very great except in extreme cases, finds that pipes may be separated into two groups according to diameters, one group comprising pipes from 8 to 48 inches in diameter and the other pipes from 3 to 6 inches in diameter.

This being premised, what are the data or elements involved in long, rough, cast-iron pipe calculations? They are three, only, as follows:

Q = cubic feet of discharge per second.
D = diameter of pipe, in feet.
h = fall per 1,000.

These items require some further explanation. The discharge Q is given in cubic feet per second. This is the most convenient form, for many reasons, and all other expressions for the discharge are easily reducible to it. For instance, suppose the discharge in a certain case was 7,550 U. S. gallons per hour. There being, in round numbers, 7.5 U. S. gallons in a cubic foot, and exactly 3,600 seconds in an hour, it is clear that:

$$Q = \frac{7550}{7.5 \times 3600} = 0.28 \text{ cubic feet.}$$

Again, the diameter of the pipe is expressed in feet. This, too, is a convenience in calculation, as it retains the same unit throughout, although the diameters of water pipes are almost invariably expressed in inches. In expressing diameters, given in inches, in feet, unless they come out in even feet and decimals, it is best to express them as a vulgar fraction. Thus the diameter of a 28-inch pipe, expressed in feet, would be:

$$D = \frac{28}{12} = \frac{7}{3}$$

Again, the fall is expressed as so much per 1,000. This, too, is a great convenience in simplifying the formulas about to be given. To this form the ratio of any slope, however expressed, is easily reduced. For instance, supposing the higher of two reservoirs, joined by a pipe line three-quarters of a mile long, was situated 342 feet above the lower one. There being 5,280 feet in a mile, the distance is $\frac{3}{4} \times 5{,}280 = 3{,}960$ feet. The total difference of level, or "head," being 342 feet, the head per 1,000 (in any unit) is:

$$h = \frac{1000 \times 342}{3960} = 86.36$$

We are now ready to set up the two simple, fundamental formulas which, directly or indirectly, solve all practical questions relating to such pipes as we have been considering, as follows:

$$\frac{Q^2}{h\,D^5} = 1 \qquad (1)$$

$$\frac{Q^2}{h\,D^5} = 0.785 \qquad (2)$$

The first applies to pipes from 8 to 48 inches in diameter and the second to those from 3 to 6 inches.

From these fundamental formulas the value of any one factor may be derived when the other two are known. Thus, from (1) we have:

$$Q = \sqrt{h\,D^5} = D^2\sqrt{h\,D} \qquad (3)$$

$$D = \sqrt[5]{\frac{Q^2}{h}} \qquad (4)$$

$$h = \frac{Q^2}{D^5} \qquad (5)$$

and from (2):

$$Q = \sqrt{0.785\,h\,D^5} = D^2\sqrt{0.785\,h\,D} \qquad (6)$$

$$D = \sqrt[5]{\frac{Q^2}{0.785\,h}} \qquad (7)$$

$$h = \frac{Q^2}{0.785\,D^5} \qquad (8)$$

To those unaccustomed to the use of logarithms, the fifth powers, and particularly the fifth roots, in the above may inspire disgust. But by recollecting that the fifth power of any number is equal to

its square multiplied by its cube, and also that all the handbooks contain tables of fifth powers, and that, moreover, (3) and (6) can be expressed in terms of squares and square roots only, with which we are all well acquainted, it will be seen that these formulas are robbed of much of their terrors. The fifth roots in (4) and (7) cannot, it is true, be obtained except by logarithms. These formulas may be solved, however, by "trial and error." That is, if we wish to find the proper diameter to discharge a certain quantity of water under a certain head, we can *assume* a diameter and insert it in (3) or (6) and see if it gives the desired quantity. If not, we can try again. Still better, we can use the following table, the use of which will be presently shown by an example:

TABLE I.

Diameters in inches.	Fifth powers in feet.
3	0.000977
4	0.004115
5	0.01256
6	0.03125
8	0.1317
10	0.4019
12	1.0000
14	2.1615
16	4.214
18	7.594
20	12.86
22	20.72
24	32.00
26	47.75
28	69.17
30	97.66
32	134.9
34	182.6
36	243.0
40	411.5
42	525.2
48	1024.0

EXAMPLES.

1. The lower end of a 28-inch pipe line is 173 feet below the surface of the water in a reservoir distant along the line of pipe 2¼ miles from point of discharge. What is the discharge, in gallons, per minute?

Here $D = \frac{7}{3}$, and $h = 14.56$. Then using second form of (3) we have:

$$Q = \frac{49}{9}\sqrt{14.56 \times \frac{7}{3}} = 31.72.$$

Then $31.72 \times 7.5 \times 60 = 14,274$ gallons per minute.

2. It is desired to discharge ¼ cubic foot per second through a pipe line 6,000 feet long, having a total fall of 60 feet. What diameter of pipe is needed?

In this case there will be some uncertainty as to whether (4) or (7) should be used. Still, as the quantity is small and the grade, $h = 10$, is good, we will try (7). Then:

$$D = \sqrt[5]{\frac{0.0625}{0.785 \times 10}}$$
$$= \sqrt[5]{0.00796}$$

By inspection of Table I. we see in the column of fifth powers that 0.00796 lies between 0.004115 and 0.01256, corresponding to diameters of 4 and 5 inches respectively in the column of diameters. If we calculate it out by logarithms we find $D = 0.38$ feet $= 4.56$ inches. In either case, since pipes are not cast to fractions of an inch, the choice lies between 4 and 5 inches. Let us test both by (6). Using first the value of

$$D = \frac{4}{12}, = \frac{1}{3}$$

we have:

$$Q = \frac{1}{9}\sqrt{0.785 \times 10 \times \frac{1}{3}} = 0.18$$

Next, using the value of $D = \frac{5}{12}$, we have

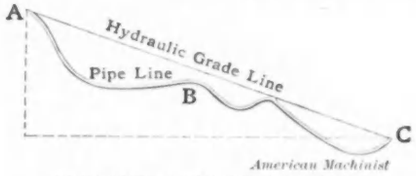
$$Q = \frac{25}{144}\sqrt{0.785 \times 10 \times \frac{5}{12}} = 0.314$$

One is too little and the other too much; if the certainty of 0.25 cubic foot per second is indispensable the 5-inch pipe should be used.

3. What "hydraulic grade" or head per 1000 is necessary to convey 6 cubic feet per second through a 2-foot pipe? Using (5) we have:

$$h = \frac{6^2}{2^2 \times 2^3} = \frac{36}{32} = 1.125$$

These three examples cover the great majority of practical cases, and can be worked by anyone capable of solving a



PRECAUTION IN PIPE LAYING.

simple algebraic equation. More complicated cases not unfrequently occur which do not admit of the direct application of the fundamental formulas, but require some preparation of the data before they can be used. Those cases, of course, require the aid of an hydraulic engineer.

One caution only is necessary in using these formulas, but it is a very important one. No part of a pipe line must rise above the "hydraulic grade line." That is to say, referring to the figure, if *A B C* represents a pipe line, then its hydraulic grade is the straight line *A C* joining its two extremities, and no part of the pipe line must rise above this grade. Therefore, before laying pipes through rough country, it is necessary to have a profile of the ground so as to be sure that the pipe, when laid, shall conform to this requirement. Neglect of this indispensable condition will lead to an interrupted or diminished flow.

At the beginning of this paper it was remarked that the fact that water will *only* run down hill was sometimes overlooked. That is to say, it is frequently assumed that a reservoir will deliver water to any point that is not situated higher than itself. This is an error. It will supply water only to points which are lower than itself, and the greater the difference of level between the reservoir and the point of delivery the greater the discharge. This is readily seen from (3) and (6). If in either of these equations $h = o$, then $Q = o$ also; that is, the discharge becomes *nil*. On the contrary, the greater the value of h the greater that of Q.

Yonkers, N. Y.

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Letters from Practical Men.

Seasoning Iron and Steel—Hardening.

Editor American Machinist:

There is certainly something in that steel seasoning story in the "American Machinist" of February 10, and perhaps I may be allowed to tag on with a few words telling how it has struck me at one or two points. Most of the old machinists have some beliefs as to the changes that go on in steel and iron pieces that are left standing for some time, but as they are not generally able to make clearly defined statements of their experience in such matters they are rather ashamed to tell them at all, and so they say nothing about it.

There is no reason after all why anybody should be so afraid about it. It is only telling over again and in another way what Mr. Outerbridge showed by a lot of experiments a couple of years ago. He put a lot of castings in a foundry rattler and tumbled them a long time, and found that it got rid of some of the strains in the metal, and that they were certainly stronger after it. Well, when things are standing around the shop for a month or a year they are not absolutely quiet, but are undergoing a gentle and continuous shaking. There is always more or less hammering or rattling going on, and they get some share of it. If I had some castings or pieces of steel that I had a notion of seasoning, I would not go and put them in the quietest place I could find, but just the opposite. If there was a fan blower running, suspended to a ceiling somewhere, I would go and lay them on the floor right over it. Then every few days I might go and turn them over.

It is possible that an "aging" machine for castings might not be an altogether absurd suggestion. If castings could be given in a day the vibrations and jars that it might otherwise take a year to impart, why might not the effect be just as good? The rapping device of the Tabor molding machine seems to have the idea that we want. That gives about 5,000 raps a minute, and anything placed on a platform to which the rapper was attached would get the full benefit of it. It might be better to have two of the rap-

pers attached, one with a vertical and one with a horizontal movement.

Now, this is not all nonsense. Quite a number of years ago a little idea right in this line had possession of me, but I was not able to follow it up as I would have liked to have done. I was straightening a lot of shafting on the lathe centers with a straightening press. The press was mounted on rollers so that it could be run from one end of the lathe to the other. I would find the high spot and then block the shaft on V's and give it a squeeze about as hard as I thought necessary. Sometimes the shaft would give too much and sometimes not at all, when I woul have to try it over again. The only way that I had of judging of the effect of the screw was by counting the turns. If I found in a particular case that three turns were not enough I would give it three and a half, and so on. There was always a good deal of guesswork about the job. Well, it happened that sometimes I would have the press on the floor, with a couple of fellows to help me. Quite a number of times when I had a shaft in the press, with a good squeeze on it, I took a light sledge and gave the shaft a quick, sharp blow or two on each end of it, and I was quite convinced, in my own mind, that the squeeze of the press had an increased bending effect on account of the shock that I gave to the molecules while under strain.

If anybody now had the same kind of a job with a compressed air straightening press, where he could tell every time by the pressure gage just how much the squeeze was, then he would be in a better shape than I ever was to judge of the effects of the blows on the end, and we might be in the way of getting some reliable figures.

As to the strains that come to tool steel when it is hardened, it is no wonder that it needs a rest, because, especially in large pieces, the strains then produced are as great as it is possible for the metal to endure, and often a little more so. It is quite worth while to inquire whether there is not a possibility of dodging some of it. We harden steel by suddenly cooling it, and usually the more suddenly we cool it the harder it is. The strains come from cooling and contracting one part quicker than another part, the latter being usually the interior. The intensity of the strain is usually determined by the difference in temperature between the interior and the exterior. After the first setting of the exterior in the act of hardening the strain increases up to the point where the temperature difference is the greatest. Large pieces cool all through quite slowly, so that the quicker we cool the outside, and the lower the temperature to which we cool it, the greater the strain created. The hardening of the steel is accomplished by the first part of the cooling. The latter part of the cooling does not increase the ultimate hardness of the piece. Why, then, should we hasten the cooling of the exterior below the point at which it is completely and thoroughly hardened? Why not give the interior a chance to catch up, to equalize its temperature with that of the exterior, without creating the greatest producible difference of temperature at any moment of the process?

It seems to me that the instructions usually given for hardening, to let the piece stay in the clean water, or whatever bath it is hardened in, until it is thoroughly and completely cooled all through, is a mistake. When it comes to the tempering we know that the temper does not begin to draw, or the least color to show, until we get the piece reheated up to about 430° Fahr. When we are hardening a piece, then, and we are satisfied that we surely have the outside, or the cutting edges, actually hardened, why should we be in any hurry at all about cooling the piece below, say, 400°?

If we cool only to 400° at first we certainly do not produce as great a difference in exterior and interior temperatures, or as great a shrinkage strain, as if we cooled to, say, 100° all at once. In hardening, then, it is only necessary to keep the piece in the first bath long enough to be sure that it is hardened, and it may then be removed to a bath of oil at 400° and allowed to cool down, oil and all together, until it is quite cold. This is not an original notion of mine, but I know that it has been done, and those who have practiced it have bragged to me of the success of their practice, and I believe they had reason to. The seasoning process will have its innings after we have, in the hardening, done our best to avoid the excessive strains, as well as if we had done our worst, as we generally do.

MORRIS FULTON.

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American Machine Tools in England—Automatic Screw Machines.

Editor American Machinist:

In your issue of December 30, 1897, the first article I came across rather upset my equanimity (I believe that is the word). It is the one entitled "American Machine Tools in England," and the gist of which is a reprint from the letter of Mr. Joseph Horner in "Engineering." This continual prating about the ignorant conservatism of the Englishman and the wonderful adaptability of the American is enough to make a man sick. Can Mr. Horner, or any of your readers, explain where the conservatism of the former comes in, when he buys so much of their improved machinery as he has done (evidenced by the stocks carried now by importers, etc.), instead of being a "blind protectionist" and purchasing tools only of local make?

If the Americans (or men who dwell in any other country) have the best facilities for making tools, by all means let them make them and we will be content to use them, as it usually pays better to do the latter than the former. Mr. Horner is, in my humble opinion, astray in some of his conclusions.

Firstly—I don't agree that it is an unmixed blessing for a firm to be engaged on one line only, in the tool-building trade, as it is calculated to make them narrow minded and put them in a groove. Whereas, by making two or three lines a better general knowledge is obtained and just as good results, in each case, arrived at, if the manufacture of each is kept, to some extent, separate. There is nothing more likely to make a man narrow minded than specialism.

There are very few large firms, as a matter of fact (so far as my knowledge goes), in America that are engaged solely on the manufacture of only one tool. Pratt & Whitney make a large variety of tools. Warner & Swaney make turret lathes and telescopes. Not much alike, are they? except that they both begin with a T.

Messrs. Tangye certainly make machine tools, but in an entirely different building and by a separate company. Their other manufactures are kept apart.

The remarks about the automatics are very misleading. There seems to be an idea among a section of the trade that you have only to get an automatic, push in the rod and get a laborer or boy to wheel away the product of about a dozen machines; whereas, you require a good tool room at the back of them and good tool makers to keep them in order, and then at the finish you must be content with a much inferior article than that made on hand-operated turrets. It would have been more convincing if the limit sizes of those screws made at Enfield had been stated, and if 3d. per 100 represents their cost the sooner they start in the screw trade the better.

Again, it is well known that hand-operated turrets can be, and usually are, worked quicker than automatic ones, although, of course, the latter can be kept more constantly at work.

Our firm exhibited automatic plain screw machines in work (of our own manufacture) at the Stanley Show mentioned, and in case your readers may think I am prejudiced I may state that we purchased the first three Spencer automatics brought into England, and most of those sold here since have been bought by persons who have first been to see ours. We have also several Pratt & Whitney automatics. The remarks anent the scarcity of English tools at the show above mentioned are quite unfair, as several of our best makers had a strike on, which at that time had been in operation several months, and others exhibited at the rival "National" Show.

The paragraph beginning with "In all these machines the bearings," etc., etc., must surely have been copied from some catalog. I, among others, badly want some of those bearings that *don't wear*. The simile about the Spanish galleon is rather mixed, is it not, or have we altered since we built those "light English vessels?" I thought we were too conservative to alter, or perhaps he made a mistake and meant to put it the other way about "the massive bearings that don't wear on the Spanish galleons."

Our Mr. Horner has evidently never heard much about Birmingham, where the best small machine tools made in England are produced, and where the good old scraper has to be used to make the slides and bearings fit, the same as they have to use in America, and for which no automatic substitute has been found. It is quite a mistake to think that the workmanship on the best American tools is better than that on the best English ditto. Having extensively tried both, I can assure you it is not, and in many cases the latter have the merit of being much simpler and the scraping of the slides to a fit is usually better done.

We on this side do not consider it good practice, for instance, for brackets of lead screws on screw cutting lathes to be bolted on. We prefer that all chance of spring should be eliminated, and therefore cast them on.

I bought some time ago an American lathe 8 feet bed, 9 inches center, and I did not notice at the time that it had the following very bad defect:

The lead screw was small in diameter, about 1¼ inch, and was "anchored" only at one end, *i. e.*, the outer end bearing only held it in line, no collars or nuts being fitted. You may be sure I do not have any left-hand threads cut on this tool. All long or slender screws should be made to work only in tension.

In conclusion, just to refer back to the "conservative" theory, I might point out that several large tool makers here are agents for American tool makers; but where can you find an American house who represents an English tool maker who is conservative? H. AUSTIN,

Works manager, the Wolseley Sheep Shearing Machine Company, Limited, Birmingham, England.

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Gap Lathes—Compound Rests—Holding Lathe Tools.

Editor American Machinist:

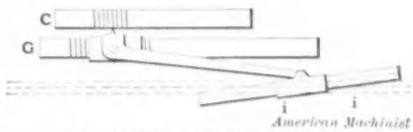
I have read with considerable interest the letters on gap lathes and four-bolt tool rests in the "American Machinist." Perhaps you will allow me to say a word or two. I quite agree with "Australian;" out here the conditions are altogether different. Of course, if business called for a number of lathes I should not have them all gap lathes. The gap lathe is a good and useful tool, with no makeshift about it, and packing up the heads in a straight bed lathe is a nuisance. I have done a lot of it, and I know what it means; but I think that if our English tool builders were to widen out the front bearer of the bed it would give more support to the saddle and stop a lot of that chattering, when, for instance, a fellow is turning a large pulley, and considering also the position of the lead-screw in a gap lathe, there is room for a few more inches in width of bed.

In reference to the four-bolt tool rest there seems to be a misconception. Mr. Fulton speaks of four bolts to tighten in place of one. Nonsense! No such thing. In all regular boring and turning we only use two. The tool is placed on one side of the rest and a packing block on the other, the same as you would bolt a job on the planing machine table, and with a spanner 11 inches long I can hold a 1¼ inch square tool under heavy cuts with no fear of its moving, and, except it was to fit a very heavy boring bar, the man who placed his tool between the studs and used the four nuts to tighten it would show he knew little about a lathe. There is a loss of time in shifting the straps from boring to turning and vice versa, but when the bolts are in T slots, as in some lathes, they are easily changed without unscrewing the nuts.

I have often wondered, Mr. Editor, why the Americans stick with such persistence to the V beds on lathes. It is very old; Maudsley's time, in fact. I remember in my apprentice days seeing two or three of these old lathes in shops in England. Also the compound rest does not seem to be much in favor with you. Now, at the shop where I was an apprentice I worked at a lathe without a compound rest; just a narrow cross slide and a single set screw to hold the tool. I was not kept long at it, but the experience I had was quite enough to convince me that I would not have a lathe without a compound rest; in fact, I would not give such lathes shop room. For instance, you are cutting a V-thread, and we all know that to get any sort of a cut and get along with the job the tool must cut on one side. With the compound rest you can adjust your tool to a nicety, and rip out a good cut; it is quick and handy; in fact, I think a lathe without a compound rest is little better than a makeshift. You make your lathe beds wide enough; you are right there, but there is too wide a span between the inner edges of the bed lathe. The tailstock base being too wide, there is no room to use the compound rest on jobs near the centers; not so in English lathes. Widen the front bearer of the bed inward, keeping the bed the same width as at present outside, and so reduce the width between the inner edges; shift the centers back central with the inner edges and take away the vees. Make a plain flat bed with square edges, lengthen the barrel around the tailstock spindle a few inches; then you will get a good width for your cross slide in the rest saddle.

Then again those balanced ball handles; they are not comparable to a nice, turned hand wheel, especially on the tailstock.

I like that two-spindle lathe, if made with flat bed and not less than 16 feet long; extra strong, with a good wide cross slide and strong compound slide rest. Dispense with the cross slide in tailstock; we don't want that; the compound rest will do the taper work or have a taper attachment; then I think we would have a very good tool for a jobbing shop. The screw-cutting device of the Frenchman, November 4, 1897, is very old; it is Maudsley's method of the bent lever and inclined straight bar. Mr. Maudsley succeeded by this means, after great perseverance, in making a very excellent brass screw about 7 feet long, and which, compared with standard measure, was less than one-sixteenth of an inch false of its nominal length. Taking the error as the one-thousandth part of the total length of the screw the system of change wheels was scarcely applicable to the correction.



CORRECTING LEAD OF SCREW.

The change of the thousandth part of the total length was therefore given to the tool as a supplementary motion, which might be added to or subtracted from the total traverse of the tool, in the mode explained by the diagram, in which all details of construction are purposely omitted.

The new screw *C* and the guide screw *G* are supposed to be connected by equal wheels in the usual manner; the guide screw carries the axis of the bent lever, whose arms are as 10 to 1, and which moves in a horizontal plane; the short arm carries the tool; the long arm is jointed to a saddle which slides upon a triangular bar *i i*. In point of fact the tool was mounted upon the upper of two longitudinal and parallel slides, which were collectively traversed by the guide screw *G*. In the lower slide was fixed the axis or fulcrum of the bent lever, the short arm of which was connected by a link with the upper slide, so that the compensating motion was given to the upper slide relatively to the lower. The triangular bar *i i*, when placed exactly parallel with the path of the tool, would produce no movement on the same, and the pitch of *C* and *G* would be exactly alike; but if *i i* were placed out of parallel 1 inch in the whole length the tool, during its traverse to the left by the guide screw *G*, would be

moved to the right by the shifting of the bent lever one-tenth of the displacement of the bar, or one-tenth of an inch. Therefore, while the guide screw *G* being coarser than required, moved the principal slide the one-thousandth part of the total length in excess, the bent lever and inclined straight bar *i i* pulled back the upper or compensating slide the one-thousandth part, or the quantity in excess, making the absolute traverse of the tool exactly 7 feet, or the length required for the new screw *C*, instead of 7 feet and 1-16 of an inch, the length of *G*. To have lengthened the traverse of the tool the bar *i i* must have been inclined the reverse way. W. ATKINSON.

Timaru, New Zealand.

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Lighting a Pumping Station by Water Power.

Editor American Machinist:

In the letter from Mr. Powell included in the article "Lighting a Pumping Station by Water," in your issue of February 3, the figure for the cost of coal per 1,000 gallons pumped should be 2.3 instead of 23 cents.

His figure for the theoretical discharge of a 21-32-inch nozzle should be 107 gallons per minute instead of 90 for a pressure of 70 pounds. The coefficient of discharge for such a nozzle would probably be about 95 per cent.; but taking it at 90 per cent. we have 97 gallons per minute, which is equivalent to 58,000 gallons per ten hours, making the cost 13.3 cents per day. Now, if an engine were used to drive the dynamo it would show not more than 3 indicated horse-power. Such an engine may surely be assumed to give a horse-power for 5 pounds of coal per hour, which would make 150 pounds of coal per day of ten hours. As Mr. Powell's coal costs $1.75 per ton the cost of lighting by the engine would be 13.1 cents, or less than with the water wheel.

The only advantage of the water wheel outfit seems to be in first cost, which would only be about half that of the engine plant. On the other hand, the water wheel shown has the worst imaginable kind of regulation. It is not only not automatic, but every time a change is made the water is cut off entirely and the effect on the lights can easily be imagined. The engine, on the other hand, would take care of any variation in the number of lights burning without any attention. In regard to the claim made in the article of an efficiency of 85 per cent. for wheels of moderate size, it is only fair to note that this wheel is not of moderate size, and the Pelton Company, the largest concern in the business, only claim 80 per cent. in their catalog for this size wheel under a similar pressure of water. As a matter of fact this wheel, according to Mr. Powell's letter, is receiving 4.4 horse-power, and if its efficiency were 85 per cent. and that of the dynamo only 75 per cent., the thirty lamps would be receiving 2,380 watts. Taking the outside figure of 4 watts per candle power the thirty 16 candle power lamps would only use 1,920 watts, and the efficiency of the wheel would only be 78 per cent.

Even as small a plant as this can apparently be run as cheaply by a separate engine. CHARLES P. PAULDING.

[The figure given for the cost of water was a typographical error. Mr. Powell's letter gave it as .23 cents—not 2.3, as Mr. Paulding has it. We make the theoretical horse-power of Mr. Powell's figure for the flow to be 3.66—not 4.4—which first value, under Mr. Paulding's figures for efficiency, would give an output for the dynamo of 1,730 watts.—ED.]

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More About Piston Patterns.

Editor American Machinist:

In the February 3 issue I see that Mr. William Pilton does not thoroughly understand my construction of large piston patterns, as described December 16, 1897. The main object was to make *cheap* and *quick*. When making patterns we always try to find thoroughly dried stock, which all patterns should be made of, and with two or three good coats of varnish the headers will not shrink to give the pattern an elliptical shape. The object in leaving spaces of 1-16 inch between the strips was to overcome this same trouble. As to truing, it is not necessary to use a small plane at all, if the lags are made, say, 1 inch wide; and as to making the three-part core, the core is lighter, easier to handle, has better drying faces and does not in any way endanger the casting; but, on the other hand, is a benefit, for the reason that the core has a better ventilation and the core maker has a better chance to make his vent. Poor ventilation in cores is the cause of a great many poor castings. The vent is made in the center and on the pasting line, up through the small round core. The lighting core, when made, has a rod bent, as shown at *B*, Fig. 1, to be used when securing the core to the cope. There is a wire run up through the small core, as shown at *C*, Fig. 1, and securely fastened. There is no strain on the paste or on the small core.

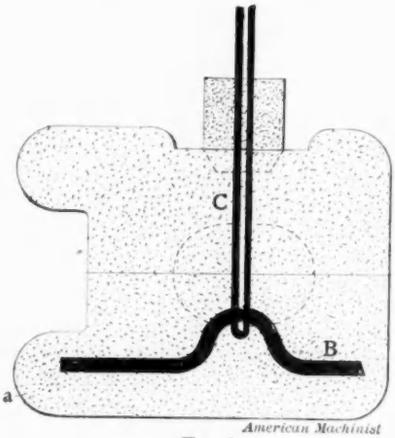

Fig. 1

TO HOLD UP THE CORE.

When setting the cores in the mold get two square sticks for each section, the size that the outer circle of the casting is to be in thickness and the same length as the face of the piston; set them into the mold, as shown at *D*, Fig. 2, and set the lighting core against them. When all are properly set lower the cope, draw up the core by wires, *C*, Fig. 1, and fasten. The strips in the mold serve as guides when setting the cores. After the cores are thoroughly secured, lift off the cope with the cores, take out the strips and your mold is ready for final closing.

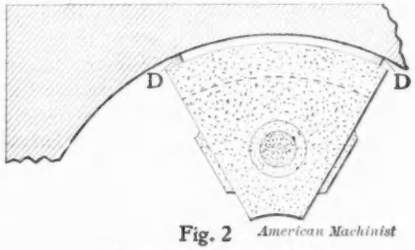

Fig. 2

SETTING THE CORE.

By Mr. Pilton's description it seems to me that corner *a*, Fig. 1, would be apt to be rather untrue. As to making in segments, it is a good way for small work; but as to time, lags could be gotten out and nailed on quicker than sawing, nailing on and turning segments; about 4 to 1 in favor of the former.

Are the readers to understand that an 18-inch piston can be finished in three hours, including core boxes and all that is necessary to get out the castings? If so it would be interesting to hear from Mr. Pilton as to how it is done.

G. H. WILLARD.

Worcester, Mass.

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Hack-Saws, Double Shaper Tool, Improvised Die Sinker.

Editor American Machinst:

The way I look at it we are not much better off in the hack-saw business than we were in 1880, when the soft Stubbs blade was the only thing, mounted in a five-eighth square steel frame, with no handle, and filed every time someone else used it. If it wouldn't saw you could sharpen it any way, which was some consolation, but now you can't file 'em, and if you haven't got an eye like an eagle, and a nerve like "Doc" Carver, you swerve a thousandth of an inch, and she's gone. You feel as though you ought to jump onto the kid for snapping the best saw you've got; but you feel some afraid to for you may get into the same fix I did.

One day I got some of those nice, flexible back hack-saws—cross between a Stubbs and a Star. I also devised a brilliant scheme for sharpening them. I sent down to Besley, in Chicago, and got a pair of those thin celluloid wheels, beveled off the edge of one of them saw-tooth shape, and did a very good job of grinding. I found I was the only man in the shop who could

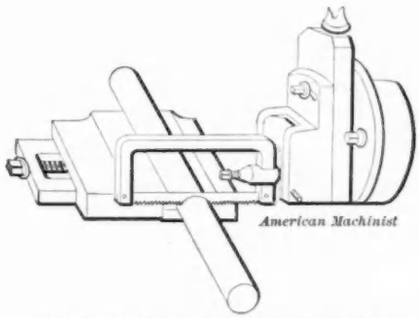

FIG. 1.—HACKSAW IN THE SHAPER.

do it, and in time the wheels wore out and the job got very ornery, and I got into the old habit of hunting for "that new hack-saw blade" with the rest of them. To-day I was thinking over the whole thing again, and there is more to the hack-saw business than has yet been developed. I observe several things; we push the saws too fast, and the arm is not steady enough to guide them true. I believe now a scheme like that shown in Fig. 1 is the proper thing to give the hack-saw a show. I think the blades should be scant 1-16 inch thick, with clearance ground same as a B. & S. saw, teeth not too fine and frequently ground, as explained above, which can be done quickly. Of course I know there are machines in the market which provide in a measure the advantages as mentioned,

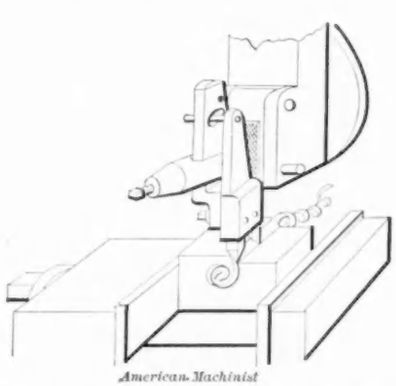

FIG. 2.—SHAPER CUTTING BOTH WAYS.

and still there are lots of shapers lying around with not much to do. The cutting-off problem is about the most serious thing a shop has to contend with.

Mentioning shaper work puts me in mind of a tool designed to make shavings at both ends of the work—how this is accomplished is shown in Fig. 2. The faces of the tool are ground parallel with each other, and the clearance is accomplished by the tip the tool gets when entering the cut.

Almost every custom shop finds the need frequently for a routing machine on dies and such things. Fig. 3 shows how we

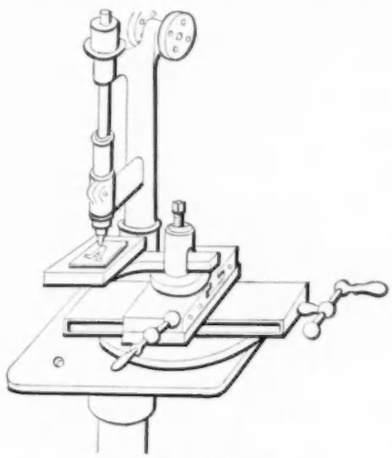

FIG. 3.—A DIE SINKING RIG.

have got along without one occasionally We robbed the fox lathe of the slide rest, bolted it on to the drill press, and there you are. L. C. SHARP.

Omaha, Neb.

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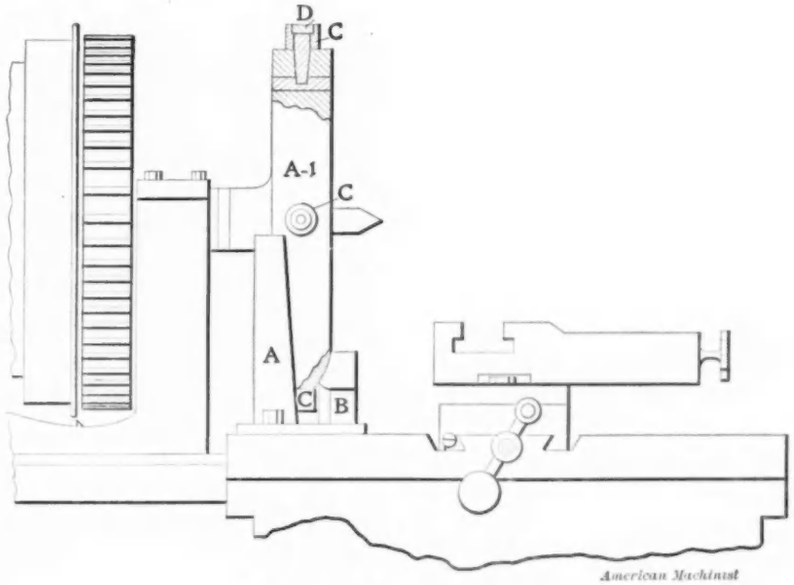
Backing-Off Attachment for End Cutters.

Editor American Machinist:

I hardly think this is a new tool, as since I made this one I have heard of several others, but they were all different from this. So, trusting that it will help some of my fellow American machinists, I take the liberty of sending you a blue print of it.

A-1 is a heavy or wide-rimmed faceplate with a number of equidistant, radial taper holes, preferably 24. *D D* are taper pins, fitting the holes, and *C C* are rollers upon them. One pin and roller are used for each cutting lip to be backed off. As the lathe spindle revolves, one of the rollers comes in contact with the beveled edge of the piece *A* fastened to the carriage, thus forcing the carriage forward and causing the tool to cut the required clearance on the cutting lip. After passing *A* the roller strikes the beveled face of the piece *B* and forces the carriage back ready for the next lip, and so on continuously. *B* is made adjustable backwards and forwards for different widths of cutting edges. As soon as the tool has finished its cut on one lip the roller should strike the face of *B* and begin the retrograde movement. Tools made this way hold their shape as long as they last, the same as regular forming mills. With the use of this backing off attachment a person can make more complicated tools—thus making one tool do the work that formerly took two or more not so correctly backed off. J. E. M.

Peoria, Ill.



A BACKING-OFF ATTACHMENT.

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How an Elliptic Gear Was Made.

Editor American Machinist:

Having described on January 6 how I laid out the ellipse for the pitch line of the elliptic gear pattern which I made, I offer a little account of my further experience with it:

I made the pattern simply to try an experiment with, and was therefore not so very particular as to its accuracy. In my previous letter I said that my centers were 7⅞ inches, but afterward I found that I could alter this dimension slightly, so I had a brass gear blank cast, with a thin web, which I finished, and cut 63 teeth, eight pitch, and, after cutting out

the web, I bored the rim to within 3-16 of an inch of the bottom of the teeth.

I then laid out an ellipse for the inside (as explained in your number of January 6) with a circumference equal to that of the bore of my gear rim and had it cast in iron. After smoothing up the casting a little I put the gear rim in the vise and squeezed it up until I could just

AN ELLIPTICAL GEAR PATTERN.

enter one edge of my ellipse, at the same time being careful to keep the center lines together, which I had struck on the gear and which were cast in the ellipse. There was considerable draft on my ellipse, and when forced in it made a good snug fit. I used wooden hubs so as to be interchangeable.

My castings came out of the sand very smooth, and when bored and placed on the shafts ran very nicely, although I found that they were about 1-32 of an inch too flat, or, in other words, the short diameter was about 1-32 of an inch too short, probably due to its being a "hurry up job." However, be that as it may, if I were to make any more I should most assuredly use the same method.

I inclose you herewith a photo of the pattern so you can tell our friend Grant that it looks well if it isn't absolutely correct. M. H. AVERY.

Woonsocket, R. I.

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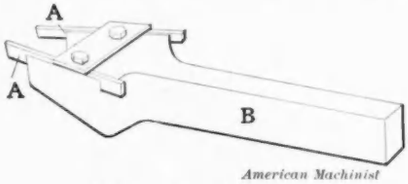
A Double Facing Tool.

Editor American Machinist:

In regard to turning and facing disks, or gear blanks, such as screw gears, about which W. L. S. wrote in your issue of February 10, I herewith submit a



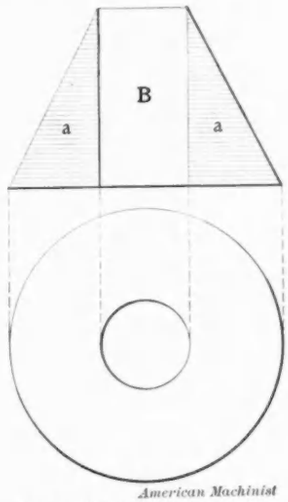
DOUBLE FACING TOOL.

method which is considered cheaper and which has been used in our works for some time.

The sketch shows two adjustable tools, *A*, of square, self-hardening steel, held in a tool holder, *B*, which holder is clamped in the regular "poppet" of an engine lathe. With this arrangement both sides are faced at once, and the thickness of the piece is obtained without calipering.

The pieces are then strung on an arbor and all turned the same diameter at the same time. G. D. C.

Fitchburg, Mass.

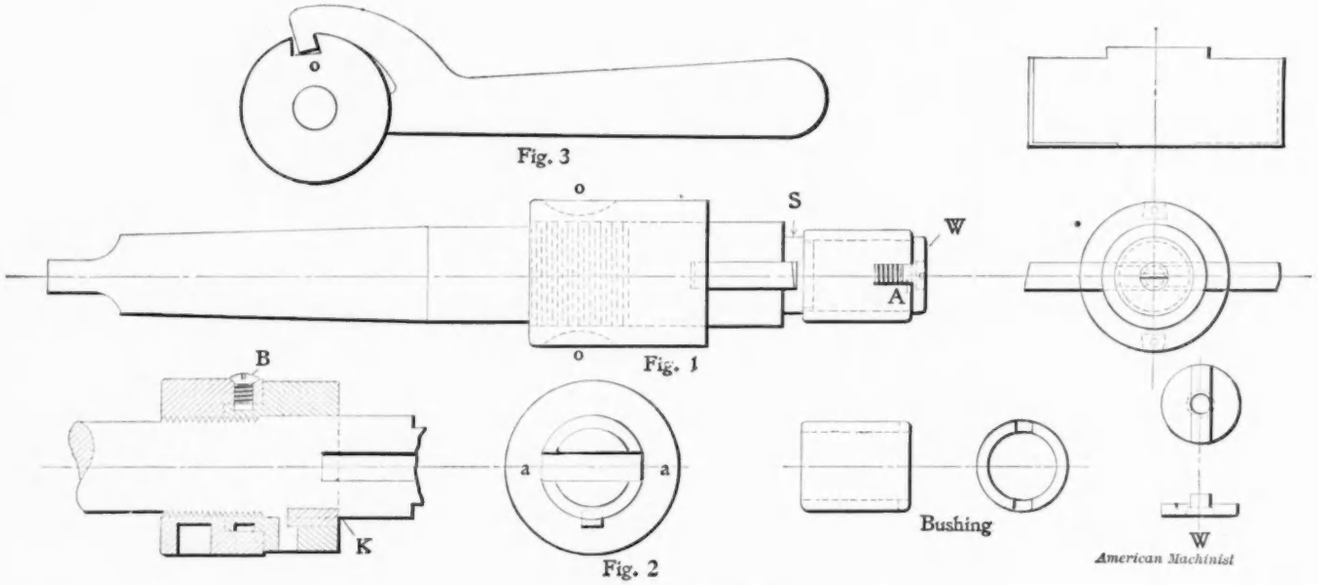


DEMAGNETIZING TOOLS.

tapering to a single turn at the end. The tool must be gradually lowered into the tube *B* and then gradually withdrawn. The device should be connected with an alternating current.

The theory is this: As the tool is lowered into the coil, at every reversal of the current there is a change in the polarity of the magnet; as the tool is withdrawn, owing to the lessening number of lines of force, the magnetism decreases, until at the end, with a single turn of wire, it is practically zero. H. S.

[Where absolute destruction of the magnetism is desired, as in watches, this form of coil is doubtless superior to the



ANOTHER COUNTERBORE.

Demagnetizing Tools.

Editor American Machinist:

I read with interest the article on "Demagnetizing Tools" in your issue of January 27.

It seems to me that the method sometimes used to demagnetize watches might be employed to good advantage. This method can easily be understood by the aid of the sketch. Some form of a brass spool should be made, as shown. The wire *a* is wrapped on this spool,

one shown by Mr. Sharp; but for shop tools we have no doubt that his form is equal to all requirements.—ED.]

▲ ▲ ▲

Another Counterbore.

Editor American Machinist:

I inclose sketches of a counterbore or cutter-bar which has some points in common with the one shown by W. A. Gowen in your issue of February 3, and embodies the suggestions you offered in connection with his description. In addition to these it has other features that will commend it to users of tools of this kind. The pilot is made an odd size, in this case 43-64, and it is intended to always use a bushing and thus preserve the size and condition of the pilot. The bushing brings up on the shoulder at *S* and is made to revolve with the pilot by means of the tongue on washer *W*, which fits in slot *A* in the end of the pilot. This tongue also prevents the screw from being forced in too tight should the washer come in contact with the bottom of a hole. I find no objection to having the sleeve and nut combined in one piece, as shown in Fig. 1, but if it is desirable to obviate all lathe work on the cutters, the nut and sleeve can be made, as shown in Fig. 2, in which the sleeve is cut out at *a-a* to fit over the cutter as it is left by the milling machine or shaper. Three screws like *B* connect the sleeve with the nut, and key *K* insures its coming in proper relation to the cutter. Making the spanner wrench and the slots in which it fits on an angle, as shown in Fig. 3, does away with any tendency toward its slipping out when in use. W. R. G.

[One thing that strikes us as peculiar, and also peculiarly difficult, about the above is the milling of the notches *o o* with the dovetailed shape as shown.—ED.]

▲ ▲ ▲

The Flow of Compressed Air Through Orifices.

BY F. A. HALSEY.

A correspondent asks for an explanation of the formula, given in "Kent's Pocket Book," for the velocity of air through orifices:

$$v = \sqrt{2gh},$$

saying that no method is given for finding *h*.

The formula will be recognized as the usual one for the flow of fluids or the falling of bodies. With fluids *h* is the head at the orifice, but with gases it is a calculated head derived from the pressure and density of the gas. Without going into the steps of the transformation the formula may be made to read, for air:

$$V = a \times 37.8 \sqrt{p \times p^1}$$

in which

V = volume of air flowing per minute, measured at the pressure of the atmosphere and in cubic feet;

a = area of the orifice in square inches;

p = absolute pressure of the air behind orifice in pounds per square inch;

p^1 = gage pressure of the air behind orifice in pounds per square inch.

The formula, as written, gives the theoretical discharge. I know of no experiments worthy of the name to determine the coefficient of discharge, but have seen some rough observations, which, while somewhat discordant, gave an average coefficient of about .75. Our correspondent's case is of a ½-inch pipe, 6 inches long, for which the coefficient would probably be somewhat less than this.

The occurrence of this problem is sufficiently frequent to justify accurate experiments for the determination of the coefficient of discharge. Now that our engineering schools are obtaining experimental air compressors through the liberality of manufacturers we may hope to have this as well as other practical problems connected with the use of compressed air solved and a return thereby made to the donors of the machines.

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Arming Your Country's Enemies.

Some time ago a Birmingham firm was stopped in its operations of making and supplying arms to some African tribes, with whom Great Britain is at war. The "London Mail" thus refers to the incident:

"A correspondent complains that if we allow Messrs. Armstrong & Co. and other firms to build battleships for foreign powers we ought not to object to other firms sending guns and rifles to the traders who supply the Afridis. The cases are, of course, absolutely dissimilar. To begin with, if we were at war with Chili, as we are at war with the Afridis, we should not allow Messrs. Armstrong to send our enemies ships. On the contrary, we should very probably requisition the enemies' ships that were finishing in our yards. The argument in favor of encouraging our manufacturers to make for foreign powers is that by so doing we establish a monopoly of the trade and insure unparalleled resources in war time. It is an enormous advantage to be able to build a warship in half the time America takes; it is no advantage to harbor a Parsee firm that trades Belgian and Birmingham rifles to our tribesmen enemies."

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Station Stops on the London Railways.

No error seems more persistent than that which ascribes to British railway cars, with their compartments and side doors, the ability to make shorter stops than our American trains can with only two doors, one at either end of a car.

The "Scientific American," which ought to know better, commenting upon rumored changes in the motive power of London's underground railways, says:

"The service was prompt and frequent and on account of the side doors, one at each pair of seats, discharging directly on to the platform, trains were emptied more rapidly and stops were briefer than on our own elevated lines, where the passengers have only two means of exit from the car."

The editor of the "Railroad Gazette," who not only ought to, but does, know the truth about this matter, says that this is misinformation, and that stops on the London underground roads average about 30 seconds, and on the New York elevated roads they are about 10 to 15 seconds.

The present writer timed a number of stops last spring on the London underground roads and found them to average about 29 seconds, and at the same time noted what appears to be the chief reason why stops are so long with the English style of car. People do get out of them quickly, but they cannot get into them quickly because, after once entering a compartment, there is no opportunity to go to another part of the train until the next stop, and consequently some care and discretion have to be used in choosing which particular door to enter. First, a compartment of a certain *class* must be chosen, and then one of that class must be found in which smoking is allowed, or prohibited, according to the preference of the passenger, and, finally, a compartment of the proper class, with suitable regulations regarding smoking, and that has a vacant seat must be found. Then, when two or more wish to ride together, or when a man, with wife and two or more children, is looking for a compartment in which all can ride together, the problem is sometimes difficult, and its solution often requires much walking back and forth on the platform and anxious peering into windows and doors, etc., all of which takes time. An American train can be entered at any point and seats found afterward, while the train is in motion.

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Under the metric system the usual unit of pressure for steam gages, indicator diagrams and general steam practice is the kilogram per square centimeter, the kilogram being 2.2048 pounds, the centimeter .3937 inch and the square centimeter .155 square inch. Then a kilogram per square centimeter is 14.225 pounds per square inch (a little less than one atmosphere), and to convert the pressure by metric units into pounds per square inch this 14.225 is used as a multiplier. To convert pounds per square inch into metric units the reciprocal of the above, or .0703 is used as the multiplier.

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Government Manufacturing Operations—The Springfield Armory

For some time past there has been trouble at the Springfield Armory, growing, primarily, we are constrained to say, out of the fact that Colonel Mordecai, who has been in command there, knows much more of military discipline and red tape than of manufacturing operations. The trouble finally was made the subject of investigation by army officers at Washington, with the result that Colonel Mordecai changes places with Colonel Arnold, who has been in charge of Watervliet Arsenal. Whether this will help matters or not we are not prepared to say; but it would look like merely a transposition of troubles. Both these men are, so far as we know to the contrary, well enough in their proper places; but to pretend that either of them knows much of manufacturing operations in a practical way is an absurdity. Both must depend upon trained mechanics and engineers to do the work which they themselves are generally credited with doing, and which the War Department is supposed to think that they actually do perform. Practically all, however, that either of them can actually do, and all that any man trained as they have been can do, is to impose military red tape and annoying regulations upon civilians who are irritated by them and upon operations that are hindered by them.

An army officer may be supposed to know what desirable features a gun should possess and should be depended upon to determine and specify those; but the responsible men in charge of Springfield Armory, Watervliet Arsenal and all other Government manufacturing establishments should be civilian trained mechanics and experienced managers of proven ability.

It is true that a paper certifying to Colonel Mordecai's ability and great success as manager of the Springfield Armory was circulated among the manufacturers of Springfield and vicinity, and was quite generally signed by them. But such a paper, in our opinion, signifies absolutely nothing whatever, except that it again shows the proverbial willingness of men to sign petitions, recommendations, etc., when the act of doing so involves no particular responsibility on their part.

We venture to say that not a single one of the manufacturers who signed this certificate of ability in behalf of Colonel Mordecai would for one moment entertain the idea of putting him in charge of his own establishment as superintendent and with full power. Furthermore, no successful manufacturing establishments in Springfield nor elsewhere is, ever has, or ever can be kept in operation by such methods.

The men employed at the Springfield Armory have enjoyed the reputation of being equal in skill and general efficiency to similar bodies of men anywhere. This has been because the immediate predecessor of Colonel Mordecai was disposed to give them a chance to be so, and to so manage things that good and self-respecting mechanics could remain there and develop themselves, as they are in the habit of doing elsewhere.

Colonel Mordecai has pursued a course there which always has been and must be utterly inconsistent with anything like general efficiency in a manufacturing establishment, where highly skilled labor is employed. In addition to utterly senseless imposition of red tape, he has, for one thing, abolished the office of Master Armorer, evidently under the impression that he could himself fill the duties of that position and make a record for himself for economy. Then, in furtherance of that same record idea, he has heavily reduced wages, in some cases at least where there seemed no good reason for reduction.

It is charged that some of the manufacturers who signed the paper above referred to were impelled to do so because they thought Colonel Mordecai had rendered a service to Springfield manufacturers by reducing the standard of wages. So far as we know no Springfield paper ever contained an advertisement for skilled men saying "No armory men need apply." This has been done in the case of different navy yard employés, however, and by indorsing Colonel Mordecai's administration those who did it have simply indorsed the methods by which such a condition of affairs is brought about. The cheapest good work is not produced in that city in which the lowest wages are paid for skilled labor.

The fact is, however, that, as we believe and have previously said, manufacturing operations for the Government should not be in charge of the army or of the navy at all, but should be in charge of a department of the Government which might properly be called the Department of Manufactures, whose official head should be a Cabinet officer, and which department should have charge of all matters pertaining to manufacturing, the same as the Department of Agriculture now has of agricultural matters.

The men in immediate charge of manufacturing operations could then be civilians, chosen and retained on account of their fitness for their positions. The present practice of placing military officers in authority over civilians conducting manufacturing operations involving skill of management and execution is an anomaly; and, considering all that American mechanics and engineers have contributed to the world's advancement, is an outrageous injustice to them.

The present system, while it requires the removal of a notoriously inefficient man, as in this case, too often does not permit an exceptionally good man who may happen to get into his right place to remain there. This is illustrated by the case of Mordecai's predecessor, Colonel Buffington. He was a good man for the place, and was probably assigned to it by some accident or fortuitous circumstance rather than by design, though we are not definitely informed on that point. We are definitely informed, however, as to the fact that jealousy of him, inspired by his unusual success in the management of the armory, led to his being transferred to an obscure powder factory, in which position it was correctly calculated that his abilities would not menace the chances of advancement of others having a stronger pull.

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Practical Hydraulics.

In another column will be found an article by Mr. E. Sherman Gould on the "Flow of Water in Pipes," of which

those who have such problems to solve should take special note.

There is no subject connected with practical engineering which from a first principle point of view is more involved than hydraulics, and, as Mr. Gould says, reference to pocket books, in attempting to solve a problem of this kind, leads one into a tangle from which most men obtain little help. Of course Mr. Gould has not covered the whole field of hydraulics. The flow of water in open channels, through orifices, over wiers, in partly filled pipes, etc., is not touched, but the flow in closed and filled pipes, which mostly interests our readers, is reduced to simpler form than we have before seen it.

Mr. Gould is a specialist in water works construction, and our readers may rely implicitly on his statements.

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Testing Lathes.

Some time ago we published some articles treating the subject of error limits in machine tools. These attracted considerable attention and called out a number of inquiries from men who wished to know what error limits should be allowed in lathes and other tools, and the best methods of determining what errors existed and the magnitude of them.

The first of these questions we do not think can be definitely answered. The limit of permissible error will vary with circumstances, and an error that would be intolerable for one man doing a certain kind of work would never be discovered by another man doing a different, though not necessarily inferior, kind of work.

The second part of the inquiry, *i. e.*, how to test a lathe, we think may be said to be very satisfactorily answered in the article on that subject published elsewhere in this issue. Much has been written on this subject, but so far as we know no method has previously been described which did not involve the making of more or less apparatus as a preliminary to the work of testing. In the method described absolutely nothing need be made for the purpose, yet the test is complete and can be made to any degree of refinement called for within the skill of the operator. The method should be frequently used. It can do much to improve the character and reduce the cost of doing good lathe work.

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American Machine Tools in England.

Our readers are, we presume, familiar with the fact that we publish many communications containing statements and expressions of opinion with which we ourselves do not agree.

In the last issue of last year we published an article which first appeared in "Engineering," of London. It was written by Mr. Joseph Horner, and we considered it an interesting criticism of some English affairs, which, however, we would not have published had it not been written by an Englishman. So far as we have observed no reply to Mr. Horner's article has been printed in the journal in which it originally appeared, but we print elsewhere in this issue a reply to it by another Englishman.

Both the original article and the reply by Mr. Austin contain statements which we cannot agree with. We cannot note all of these, but it may be well to refer to some of those which occur in the latter communication.

We can assure Mr. Austin that there is no considerable number of American manufacturers who do not understand that good tool-making is a condition to the successful operation of automatic screw machines, and in our humble opinion the fact that American manufacturers have generally arrived at very clear ideas on that point is just where they have an important advantage. Good tool-making is at the foundation, and is, we believe, the main cause of our success as manufacturers. Our mechanics know how to make good tools and keep them in good working order, and our manufacturers are willing to spend the money necessary to pay for them. Perhaps this fact has something to do with the circumstance that it is by no means the case here that he who operates automatic screw machines must be satisfied with work inferior to that made on machines with hand-operated turrets.

As to comparative workmanship in machine construction we think it is doubtful if comparisons can be accurately and at the same time broadly made as between the two countries. We believe there is not much choice between the best work of the two countries so far as accuracy is concerned, and the same may be said of the worst work, perhaps, *i. e.*, it is about equally bad whether made here or in England.

In regard to cast-on or bolted-on lugs both practices are followed here. We think that a lug can be bolted to a lathe bed so securely that no error or trouble caused by its springing will ever manifest itself, and as for placing collars at both ends of lathe lead-screws, that was the former practice here, but has been generally abandoned in the belief that, considering the fact that screws expand and contract by changes of temperature, it is better to place both collars at one end and leave opportunity for free contraction and expansion at the other. We think that the notion that a lathe lead-screw should be always in tension is a mistaken one, attributable in part, perhaps, to the fact that the carriage of an English lathe usually offers much more resistance to movement than is the case with our lathes. In no case of threading should the resistance be sufficient to cause trouble from buckling or from the fact that the screw is slightly lengthened by tensile stress and shortened by compressive stress. Other errors in ordinary screw cutting, whether it is done in an English or in an American lathe, are likely to be much more important.

Finally, we may say that by the well-established rules of logic it is not permissible to declare that one of two or more possible causes of a given effect is the true or only cause until it is proven to be so, and it is at least possible that the relative merits of English and American machine tools have an important bearing upon the fact that our tools go to England, but that English tools do not come here. We do not assert that this is positively demonstrated, but it seems a fair inference from the evidence that can be found, not only in Great Britain, but all over Europe.

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Royalty Payments on a Grip Mechanism.

A case of some interest to inventors, to employers of inventors and to users of patented inventions generally was decided a few days ago in the United States Circuit Court. Charles I. Earll was employed by the Metropolitan Traction Company, of New York, which owned the Broadway and the Seventh avenue lines. He was a draftsman, and while working for the company above named invented a grip mechanism, a work to which he was assigned. A patent was granted upon this grip in 1894, and by the terms of the agreement the company named was to have the right to use the invention without payment of royalties. Earll brought suit for payment of royalties, claiming that the present Metropolitan Company is not the one with which he made the agreement and has no right under it. The Court held that the present Metropolitan had acquired by succession the rights to the invention on those lines owned by the original company at the time the agreement was made, but decides that royalty must be paid for the use of the grip on other lines owned or operated by the present company, but which were not owned or operated by the company with which Earll made his agreement.

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Effect of Strike Settlement on Export of Machine Tools.

We have taken occasion to make some inquiry among leading tool builders who have been doing considerable business abroad as to the effect of the settlement of the engineers' strike so far perceptible. The reports differ very widely. Some of our correspondents report a very decided increase of orders, while others who would be thought to be fully as likely

to feel the effects of the settlement say there has been no perceptible change.

The general impression is that British manufacturers will, as a result of the new conditions, buy American tools in increased numbers during the next few years; but this increased buying is expected to take place mainly in the smaller and medium sizes.

On the other hand, the settlement is expected to make English competition on the Continent more vigorous, and this will especially be felt in the heavier tools. In fact, we are informed of one important order which had been given to an English shop and will soon be filled there, but which, had the strike continued a short time longer, would have been withdrawn and placed here.

One American builder, who has been doing a large business abroad, states his emphatic belief that his foreign business will increase. He declares he sells his tools abroad because he finds people there who prefer them to any tools they can buy of European manufacture, and he confidently expects to maintain this lead; declaring also that, quality for quality, he can build tools and put them down in European shops at as low cost as builders in any other country can do it.

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What is said to be the largest and finest private yacht ever built in this country was launched on the 19th inst. at Wilmington, Del. The vessel has been built for Howard Gould, who inherited a fragment of Jay Gould's fortune—a mere bagatelle—George Gould being the principal heir. The yacht is 272 feet long, 36 feet beam, and is magnificently fitted up, among her other novel features being a very complete and fully equipped armory. The engine cylinders are 18 inches, 28 inches and 45 inches diameter, 30 inches stroke. There are two sets of engines; 450 tons of coal can be carried. The yacht is said to have cost "not more than $500,000." Sixty men will be required to navigate her, and the yearly cost of running the vessel will, it is said, amount to about $100,000.

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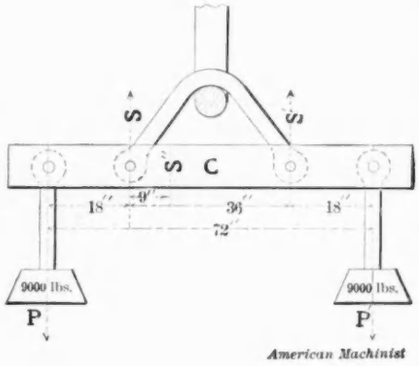
Questions and Answers.

Name and address of writer must accompany every question. Questions must pertain to our specialties and be of general interest. We cannot undertake to answer questions by mail.

(18) H. L., Troy, N. Y., asks what is the usual practice in measuring the depth of keyseats in pulleys and shafting? Is the depth measured at the edge of the keyseat or from the circle at the center? A.—The usual practice is to measure the depth at the side of the keyseat, though sometimes it is convenient to determine the corresponding depth for the middle of the keyseat measured from the circumference of the shaft, and this depth is then used in sinking milling cutters into the shaft, the measurement being made by the micrometer, with the touching point of the milling cutter as the basis of the measurement.

(19) A. A. E., Detroit, Mich., has a beam supported and loaded as shown in the sketch, and he asks: What are the bending moments at S and C and how are they calculated? A.—This question appeared a few weeks ago, and we repeat it now with our answer, because the illustration designed to go with it was inadvertently omitted. In cases of this kind determine the magnitude of the reactions of the support and consider them as applied forces acting upward. In the present case it is obvious that reactions S and S' are each equal to P and P' or 9000 pounds. To find the bending moment at any section consider the forces which act downward as positive and those which act upward as negative, and take the algebraic sum of the moments of all forces on one side of the section. At S or S' the moment is that of P or P' only, or $18 \times 9000 = 162000$-inch pounds. At C the moment of P is $36 \times 9000 = 324000$ inch pounds and that of S is $18 \times 9000 = 162000$-inch pounds. The moment of P is positive and that of S negative, the algebraic sum being 162000-inch pounds—the resultant moment at C. Note that the same moment will be obtained for all points between S and S'. Thus take S'' where the moment of P is $27 \times 9000 = 243000$-inch pounds, while the moment of S is $9 \times 9000 = 81000$-inch pounds, the resultant being as before 162000. We have disregarded the inclined action of the bale, as we infer that your perplexity does not relate to that.



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Electricity's Unique Advantage.

In the third of the Columbia University lectures upon electrical engineering at the American Museum of Natural History on February 19, the lecturer, Dr. A. E. Kennelly, whose topic was the "Transmission of Electrical Energy," had, perhaps, if strictly adhering to his subject, less to communicate than either of his predecessors, and yet in certain lines his lecture was to the listener the most suggestive of all. In the transmission of power by water, by steam or by compressed air we have usually a choice between high pressure with a given volume, or lower pressure with a commensurately greater volume. The employment of the high pressure and the small volume is with water or gases by no means an unmixed gain of economy in transmission. The size of the conveyor is reduced, but its strength must be at the same time increased. We may transmit compressed air, for instance, through a 6-inch pipe and at a pressure of 90 pounds to the inch, or we may transmit its equivalent through a 2-inch pipe, but at a pressure of, say, not less than 1,000 pounds to the inch. The difference in the strength of pipe required is evident, and the necessity of greater precautions against leakage.

In the transmission of electrical energy conditions occur quite analogous to the pressure and volume of water, steam or air, and there is usually with it also a similar choice of high pressure, or voltage, with small volume, or amperage, or *vice versa*. With electricity this gives a choice between the possible and the impossible in transmission much more pronounced than with any of the other agencies. The use of high voltage has greatly increased the possibilities of long distance power transmission. With low voltage the mere cost of the wire for transmission soon becomes prohibitive, but the increase of pressure secures a reduction in the cost of the line much greater than is the case with piping for air or liquids. No additional mechanical strength is called for as with piping, but leakages occur quite similarly.

In the transmission of electrical energy to great distances or in great amount the transformer plays an important part. Here is a unique and, as some might say, an unfair advantage which electricity has over everything else. With mechanical pressures and with temperatures the hitherto uncircumvented tendency is always to run down. To change from the higher pressure to the lower or from the higher temperature to the lower without inequitable loss is simple enough; but to change in the other direction is practically impossible. We have indeed mechanical means such as the hydraulic ram or an additional and complicated air compressor, but nothing economically to correspond to the step-up and step-down electrical transformers. The electrical engineer produces his current as cheaply and as best he may; then by his transformer he packs it for its journey; at the other end, or at different points along the line he draws it off and transforms it again to exactly suit his then special purpose.

The above is by no means a sketch of the lecture, and much of it is what was not said, yet all deducible from it with little effort. Much that was rather looked for and which might have been so easily said was not. The subject of the transmission of electrical energy is perhaps, in an economic view, its most vulnerable point, but not a word was offered or suggested as to the cost of transmission or of the losses in transmission, the one thing most uncertain and concerning which all are most anxious to know. All were assured, however, that electricity is the safest known means of power transmission, and some information as to the dangers from the electric current was given. A horse is killed

much easier than a man. A current of 100 volts, as from an incandescent light circuit, is hardly worth noticing; the usual current of a trolley line, say 500 volts, will not kill a healthy man; from 1,000 volts upward the current is usually fatal to human life.

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Foreign News Notes.

Caracas, Venezuela, is open for an electric railway service.

Peru will soon offer, through all of her principal cities, opportunities for the installation of electric light plants.

The Buenos Ayres importers are complaining of the American methods of packing electrical machinery. Shipments from England are received in better condition.

Electrical manufacturers will soon be given an opportunity to bid on the transformation of the street railways of Mexico to electric motor systems. $5,000,000 will be expended in the enterprise.

Guatemala admits electric batteries, uncharged, free of duty, if they are intended for public use. The duty on galvanized iron wire and insulated copper wire for electrical purposes, and electrical apparatus, are subject to duty upon their gross weight.

In Belize, British Honduras, there will soon be a call for a complete fire apparatus, which is expected to include two steamers, hose, trucks, ladders, water tower, mains and hydrants. Albert E. Morton, United States Consul, will furnish all necessary information.

An opening is being made in Mexico for agricultural machinery by the development of that country's boundless resources and wealth. Our capital is also largely interested in the development of its mines, and this gives opportunity for our manufacturers. Manufacturing, in all its varied forms, is being developed, and here again there is a call for new machinery.

The attention of American manufacturers of machinery, also those of mining and engineering equipments, should be called to the Bolivian markets. While it has been exceedingly difficult to obtain official statistics it is obvious to onlookers that there is going to be a boom in mining, and, as a result, small but good orders may be picked up most any time for machinery and implements. A difficulty to be overcome is the mule service used in transportation.

A. F. TENNILLE.

Washington, D. C.

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Obituary.

Gottlieb Moyer, the oldest retired ironmaster of Pennsylvania, died at St. Lawrence, Pa., on February 24. Mr. Moyer was ninety-four years old. He was operating forges in the country east of Reading more than seventy years ago, his father having been in the same business before him. He sold iron as high as $100 a ton, and made money rapidly. He was in the business over fifty years. Most of his property was distributed to his children years ago.

John Gundry, superintendent of the Tamarack-Osceola Stamp Mills, died at South Lake Linden, Mich., February 5, 1898. Mr. Gundry was born in Cornwall, England, in 1839, going to the copper region of Michigan when twelve years old and learning the machinist's trade. His ability and reliability led to his advancement, and he had been superintendent of mine machinery, or stamp mills, for more than a quarter of a century.

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Personal.

Kindly oblige us by sending in personal items regarding changes of foremen, superintendents and others prominently connected with the machine business.

Dr. Edgar Kidwell, Professor of Mechanical and Electrical Engineering, Michigan College of Mines, has resigned. Joining the institution in 1890, when it was in the organization stage, he did much toward bringing it up to its present eminence, and his contributions to this and other technical journals on subjects connected with technical education have attracted much attention.

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C. W. Burton, Griffiths & Co., of London, who are British representatives of a number of our American tool builders, inform us that they have moved into new and much more commodious quarters at Nos. 1, 2 and 3 Ludgate square, Ludgate Hill, London, E. C. The new warehouse and showrooms have over 7,000 square feet of floor space, and are well equipped with hoists and every facility for handling and exhibiting machinery. At the same time it is the intention to retain the old warehouse, at 158 Queen Victoria street, for showrooms.

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The superintendent of one of the large pump companies in describing a power pump recently built says: "A power pump differs from a steam pump inasmuch as it derives its motive power from water *or electricity* and not from steam." There is rather too much of this in circulation among people who certainly know better. Electricity drives nothing, except as it is itself first driven.

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In some of the latest flat or apartment houses in this city the occupants are spared the trouble of handling or looking after ice. A refrigerating plant is provided for the entire building, and run by the engineer, and pipes are then laid to each refrigerator.

Commercial Review.

NEW YORK, Saturday Evening, Feb. 26, 1898.

WOOD-WORKING MACHINERY.

In wood-working machinery, as in so many other lines, this winter has marked an epoch of improving business conditions. So, at least, do we judge from the talk in offices in New York city. This branch of industry has had to struggle against so many adverse influences that any favorable report from it is peculiarly gratifying. There is not the future for wood-working machinery that there is for many other lines, and a boom in it is almost a moral impossibility, now or at any other time; but there certainly are signs that it is returning to a healthier basis than heretofore.

The topic of chief interest in this department of the market is naturally the progress of the American Wood-Working Machinery Company, which was formed during the latter part of 1897 by a consolidation of existing companies. This has now become a "going concern," with its system of sales agencies throughout the country, and from the sign-board put up beside the door of its local selling office can be read in black and gold an answer to the mooted question, Who is in it and who is not?

The concerns to which it has succeeded are eleven in number, to wit: F. H. Clement Company, Glen Cove Machine Company, Goodell & Waters, Rowley & Hermance, Hoyt & Brother Company, Lehman Machine Company, Milwaukee Sander Manufacturing Company, C. B. Rogers & Co., the Levi-Houston Company, Young Brothers Company, Williamsport Machine Company.

From this list it may be seen that the J. A. Fay & Egan Company, of Cincinnati, which was one of the chief originators of the consolidation, has not become a part of it. Neither has the S. A. Woods Company, of Boston, which, according to the newspapers, had been bought out by it just after its organization.

The two of the older concerns which seem to constitute the controlling element in the new organization are the Glen Cove Machine Company and firm of Rowley & Hermance. The present executive offices of the American Wood-Working Machinery Company are at 50 Broadway, New York, hitherto the home of the Glen Cove Machine Company. The Eastern sales office is at 109 Liberty street, where, of old, the agency of C. B. Rogers & Co. was located. The New York and Boston sales offices cover most of the United States as far west as the Mississippi; but the State of Pennsylvania is attended to from Williamsport. The territory west of the Mississippi is chiefly controlled from the Chicago office, but a separate agency is to be established for the Pacific Coast. It is

said that the company is closing some of the shops under its control.

From the fact that the Fay-Egan, the Berlin, the S. A. Woods and other important concerns are not included in the new company it will readily be perceived that the plan of creating a monopoly in the wood-working machinery market, if such were originally the intention, has by no means been carried out. The company cannot be charged with being a "trust" which can endanger competition or raise prices to exorbitant figures. It furnishes a means by which a number of concerns, several of them weak ones, have united for their mutual satisfaction, leaving the producing facilities of the market amply well distributed between itself and rival interests.

We have talked with the New York representatives of several concerns not included in the consolidation, and they did not seem in the least worried over the new conditions they had to face. In fact the sentiment is rather that outside shops will be benefited thereby. This is obvious from at least two causes. First, the competition is much narrowed. A certain seller tells us that some seven out of the eleven consolidated companies were direct competitors of his, so that now he has only one opponent to bid against in the place of seven. It is easy to see that the chances of one of his rivals either intentionally or accidentally hitting below his figures are materially diminished. Second, it is inevitable that in the merger of an old company into a new one with a new name some of the good will belonging to the former one will be lost. A customer who has been in the habit of dealing with a particular company for years and has come to regard it as an old friend, and then comes to find it masquerading under a new name with new officers and new interests involved, will be likely to feel that he has nothing in common with it any longer, and to fall readily into the hands of one of its rivals. To show that this is no idle speculation we may mention having heard of an illustration of it in the sale of a planer and matcher by an outside company only the other day, which would not have been sold by it but for the consolidation. This may be very unjust to the consolidated company, because the tool it offers for sale may be identical with that on the market before the merger. We daresay, however, that there are other economical considerations, such as avoidance of diffuse effort in doing business, which compensate for the disadvantages to which we have alluded, and we hope for their own sake that the merged companies will not so obscure their personality as to lose the customers which they have won by their good service in the past.

In regard to the matter of prices it is said that the American Wood-Working Machinery Company has diminished discounts from 45 per cent., the former figure, to 40 per cent., and that these firmer figures are likely to be held better on small machinery than on large.

Business is reported active with the J. A. Fay & Egan Company, of Cincinnati. Among the most important of recent orders was that for nearly thirty car-building machines for the John Stephenson Car Works.

PITTSBURG REPORT FOR FEBRUARY.

During the past few weeks there has been quite a marked degree of activity shown in the raw iron market, especially in this district. Probably the largest deal consummated for some time past was that made by the Carnegie Steel Company, Limited, which purchased about 100,000 tons of pig. This deal strengthened the general market considerably, and a great deal of interest has since been manifest. The purchasers concluded that "bottom" prices had about been reached, which later resulted in more activity and a higher notch in figures. This movement in pig iron will result in an increased activity in finished lines.

Rolling mill machinery, as far as the demand is concerned, is about holding its own. The main cause for complaint is the exceedingly low prices that must be made to secure work. At present there are several large contracts pending which may be closed at any time. The Frank-Kneeland Machine Company has been successful in securing orders for mill machinery, particularly those for the Carnegie Steel Company's new blooming mill at Homestead, and the new rolling mill plant of the Old Meadow Rolling Mill Company at Scottdale, Pa. The Leechburg Foundry & Machine Company has also contracted to furnish the Shenango Valley Steel & Tin Plate Company, of New Castle, Pa., with thirty doubling shears, this probably being the largest order ever given for doubling shears to a single concern. The new universal mill (plans of which are about prepared) which the Carnegie Steel Company is to erect will be of the most modern construction. Electric cranes and other improved machinery will be installed.

The engine and boiler builders of this locality are pretty well filled up with orders, and are kept busy figuring on new work. The Epping-Carpenter Company, of Pittsburg, manufacturer of steam pumps, is to erect a new plant and will install a power plant of about 150 horsepower. The American Steel Casting

Continued on page 41.

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Business Specials.

Gear wheels, gear cutting. Grant; see page 20.

Power hammers, Jenkins & Lingle, Bellefonte, Pa.

Forming Lathes. Mer. Mach. Tool Co., Meriden, Conn

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N. Y

Wanted—One machine shop in every county to manufacture my Patent Balance Slide Valve. Geo. Wolf, 251 Birch street, Cleveland, Ohio.

Wants.

Situations and Help Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. The cash and copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Situations Wanted

Mechanical draftsman, 7 yrs. exp. Box 96, AM. MACH.

A1 die sinker, 7 y's. exp., wants sit. Box 104, AM. MACH.

Pos. by d'ftsman (tech. grad.) with shop exp.; fam. with ch'less bicycle con., tools, jigs. Box 109, AM. MA.

Draftsman and machinist, exp. in general machine works, wants situation. Box 88, AMERICAN MACHINIST.

Successful mach. shop foreman desires pos.; up in modern methods and a hustler. Box 105, AM. MACH.

Machinist—Young man, age twenty-seven, good mechanic, would like position in machine shop; good references. Box 103, AMERICAN MACHINIST.

Wanted—Position as foundry foreman by a competent and experienced foundry man; engine machinery or jobbing. Box 100, AMERICAN MACHINIST.

Young man (23), technical graduate in Germany, with three years' experience in France, wishes position as draftsman or salesman. Address Box 106, AM. MACH.

Mechanical engineer, graduate from German college, experienced, from the practical work in shop to superintendence and management of manuf'g, open for engagement as supt. or chief engineer. Box 97, AM. MACH.

Wanted—By M. E., of fifteen years' experience, a position as manager or supt. of mach. works, building special machinery or taking large contract work; large exp. in estimating prices and handling men to advantage; best references. Address Box 102, AM. MACH.

An energetic and capable mechanic, 35 years old, 17 years' shop experience (9 years as foreman), a first-class draftsman and designer of small tools and jigs, would like to make a change; mod. salary to start with, if promotion is possible; ref. Box 101, AM. MACHINIST.

Mechanical engineer, tech. grad., with seven years' experience in shop, and in charge of design and erection of engines, boilers and power appliances, one year in charge of large Electric R. R. plant, desires position; references. Address Eng., L. Box 91, Hartford Conn.

An expert mechanic and mech. eng. wants a change about May 1 next; thirteen years' experience in four places as designer, foreman, supt., superintending eng.; strictly temperate; not afraid of work, and a hustler; can give past and present emp. as ref. Box 99, AM. MACH.

Mech. eng., thorough technical education, with good executive ability, desires change; competent and exp. designer and constructor; est. and cost reduc.; position as supt. or assistant mech. eng. preferred; best of ref., including present employers. Box 98, AM. MACHINIST.

Accurate, inventive ability, 17 years' exp. on special tools and mach. for the production of high grade interchangeable work; desire pos. as foreman, supt. or in any capacity requiring the services of a sober, reliable, modern mechanic. Address Expert, AM. MACHINIST.

Help Wanted.

Wanted—Several first-class vise hands, experienced on machine tool work. Address Vise, AM. MACHINIST.

Wanted first-class erecting shop foreman. Address the Bucyrus Company, South Milwaukee, Wisconsin.

Wanted an instructor in pattern making and foundry work. Address, stating experience, age, salary, etc., Box 94, care of AMERICAN MACHINIST.

Draftsman wanted; one accustomed to engine work preferred; give reference, experience and salary expected. South, care AMERICAN MACHINIST.

Wanted—First-class tool-maker; give past connections, kind of work engaged upon and wages expected. Bickford Drill & Tool Co., Cincinnati, Ohio.

Wanted—One good all-around machinery blacksmith; steady work, good wages; give age, experience and nationality. Burlington, care AM. MACHINIST.

Wanted—Capable and energetic foundry foreman for Eastern Canada; shop running heavy work; about twenty men; slide valve and Corliss engine work. Address Box 73, AMERICAN MACHINIST.

Wanted—Foreman for a machine shop; a competent man can have permanent situation. Address, inclosing references and giving age, and present or former occupation, Am. Wood Working Mach. Co., Green Bay, Wis.

Wanted—One or two good machinists; lathe hand preferred; a good mechanic and man of good habits will have steady job; we prefer men between thirty and forty years old. Apply to or address Kenney & Co., Scottdale, Pa.

Wanted—A salesman for special line of machine tools; must be a good mechanic, having experience in the use of turret lathes, automatic screw machines, milling machines, and in designing and making tools. Box 77, AMERICAN MACHINIST.

Foreman wanted—An energetic, thoroughly practical mechanic, familiar with the manufacture of sewing machines, typewriters, firearms, or other articles of like character, who has had a successful experience as foreman, and is acquainted with up-to-date appliances for economical manufacture, and fully competent to obtain the most satisfactory results from facilities furnished. Address, with references, stating age, experience and salary expected, Practical, care of AMERICAN MACHINIST.

Help Wanted.—Continued.

A superintendent of engine works on permanent night shift; applicant must have had experience in producing good work cheaply; tools are fully up to date; vicinity New York; applicant must state salary expected, and, if possible, relative cost of day and night work under his previous superintendence. Address Box 90, AMERICAN MACHINIST.

Miscellaneous Wants.

Advertisements will be inserted under this head at 30 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Wanted—Lathe and planer. 7 Quay street, Buffalo.

Book, Dies & Die Making, $1. J. L. Lucas, Prov. R. I.

For selling or buying tools apply J. Klein, South Parade, Manchester, England.

The Dutton Wet Twist Drill-Grinder is sold by the Garvin Machine Co., New York City.

Wanted to buy a good second-hand pulley lathe, to swing not over 20 inches. Box 107, AM. MACHINIST,

Wanted—The latest improvement in gas and gasolene engines. Address F. C Austin Mfg. Co., Chicago, Ill.

For Sale—Second-hand drill presses, engine lathes and planers. Dietz, Schumacher & Boye, Cincinnati, O.

Best and cheapest Bolt Header, made by Baush & Harris Machine Tool Co., Springfield, Mass.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

I need several small high speed engines with three or four radial cylinders, similar to "Brotherhood" or "Cross." Send prices to Box 108, AM. MACHINIST.

Lathes, planers, drills, milling machines, vises, also brass working machinery second-hand; must be modern and in first-class condition. C. C. Wormer Machinery Co., Detroit, Mich.

If you use brass, bronze or composition castings in large quantities, write to us for prices. Jas. J. McKenna & Bro., 424 and 426 East Twenty-third street, New York. Established 1833.

Wanted—To correspond with parties having some specialty in the line of machinery to build, by one of the best equipped foundry and machine concerns in the Middle States. Address Box 80, AM. MACHINIST.

Manufacturer desiring a specialty should investigate small auto. refrigerator machine using no ammonia; four patents pending; no experimental work required; best reference. Refrigerator, AM. MACH.

I have all the volumes of the AMERICAN MACHINIST bound in cloth, minus advertising, from No. 1 to 17, inclusive; volumes 18 and 19 and part of vol. 20 unbound; how much am I offered for the lot? Walter Howley, Bangall, Dutchess Co., N. Y.

An American, residing in England, already calling upon users of all kinds of machinery, would like to correspond with manufacturers or patentees, with the view of representing them in England or on the Continent. Address A. E. L., 135 Balfour st., Hull, Eng.

Brains and hands do their best work in the field of their experience. The Century Machine Co., 576 West Broadway, New York, employs trained brains and trained hands in the persons of mechanical experts who are competent to solve intricate mechanical problems and make operative models. The designing of automatic and labor saving machinery is in charge of Mr. Oluf Tyberg and assistants. The Century Machine Co. is equipped with most modern tools as well as men. Light machine work, experimental work, model making and manufacturing solicited.

EXPORT TRADE.

English engineer wishes to represent American firm in Europe; fluent German; some French; has had experience in English trade. Box 91, AMERICAN MACHINIST.

FOR SALE.

One-half interest in United States patent No. 580,027, Wiltse's improved wrench; a complete invention; simple, practical, efficient; this improvement is designed for very quick and convenient adjustment and is very substantial in its construction, while but little cost is involved in its manufacture; the implement is compact, strong and has no harsh, massive projections; indorsed by gas and steam fitters, plumbers, master mechanics of leading railroads, &c.; sells on sight; large profits; $1,000 required. Address OWNER, P. O. Box 850, Denver, Col.

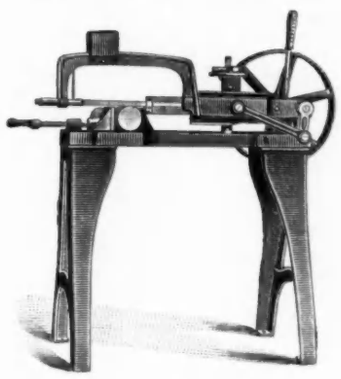
Industrial Manufacturing Novelties WANTED.

A well-known Austrian wholesale supply house will publish an 1898-99 edition of an illustrated Catalogue and Price List of 20,000 copies. This firm wishes to include novelties likely to be in demand by manufacturing establishments of all sorts—by mines, railroads and on the farm—so that such novelties shall be the soonest made known and practically introduced.

The early transmission of offers of such industrial manufacturing novelties is requested; they are to be marked "TECHNIK, W. 20,000" and sent to the Advertising Agency of RUDOLF MOSSE, Wien I., Seilerstätte, 2.

"The best is as good as any."

The New Automatic and Gravity Feed Q & C Shop Saw

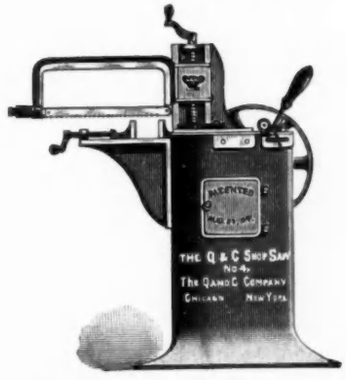


Cuts { Tool Steel, Machinery Steel, Iron, Brass and All Other Metals.

Price—'Way Down.
Quality—'Way Up.

Shop Saws,
Portable Rail Saws,
Cold Power Saws,

For All Purposes.



Send for Catalogue.

Q & C Company,

Chicago. New York.

LONDON: Chas. Churchill & Co.
PARIS: Hounsfield & Fils.
BERLIN: Schuchardt & Schutte.
MADRID: J. G. Neville & Co.

Company, of Sharon, Pa., is to enlarge its plant and will place additional engines and boilers.

Of the new concerns in this vicinity who intend erecting or making additions to present plants the following may be mentioned: P. H. Phillips Machine Company, Buffalo, N. Y., will add to the plant of the Pittsburg Car Wheel Company, Pittsburg; New York Car Wheel Works, Buffalo, N. Y., will erect a new plant at New Castle, Pa.; Messrs. John Guthridge and J. F. Findlay, Niles, Ohio, will erect a small rolling mill at Wellsville, Ohio; Douglas & Whisler Brick Company, Rochester, Pa., will erect a brick manufacturing plant at Vanport, Beaver County, Pa.

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Quotations.

NEW YORK, Monday, February 28.

Iron—American pig, tidewater delivery:

No. 1 foundry, Northern	$11 50	@	12 25
No. 2 foundry, Northern	10 75	@	11 50
No. 2 plain, Northern	10 50	@	11 25
Gray forge, Northern	10 25	@	10 50
No. 1 foundry, Southern	10 75	@	11 00
No. 2 foundry, Southern	10 25	@	10 50
No. 3 foundry, Southern	10 00	@	10 25
No. 1 soft, Southern	10 75	@	11 00
No. 2 soft, Southern	10 25	@	10 50
Foundry forge, Southern	9 75	@	10 00

Bar Iron—Base—Mill price, in carloads, on dock: Common, 1.07½ @ 1.10c.; refined 1.15 @ 1.20c. Store prices: Common, 1. 25 @ 1.35c.; refined, 1.30 @ 1.50c.

Tool Steel—Ordinary sizes, standard quality, 6 @ 7c., with some grades perhaps a little less; extra grades, 11 @ 12c.; special grades, 16c. and upward.

Machinery Steel—Ordinary brands, from store, in small lots, 1.45 @ 1.60c.

Cold Rolled Steel Shafting—Base sizes, from store, in retail lots, 2.20 @ 2.25c.

Copper—Carload lots. Lake Superior Ingot, 11¾c.; electrolytic, 11½c.; casting copper, 11¼c. copper, 11¼c.

Pig Lead—Carload lots, 3.72½ @ 3.75c., f. o. b. New York.

Pig Tin—For 5 and 10 ton lots, 14.30 @ 14.35c., f. o. b.

Spelter—Carload lots, 4.10 @ 4.20c., New York delivery.

Antimony—Fair wholesale prices on the various brands, 7.60 @ 8.25c.

Lard Oil—Prime City, present make, 44 @ 47c.

▲ ▲ ▲

Manufacturers.

The Champion Silk Mill, at Pottstown, Pa., is to have an addition erected.

The E. Keeler Company, of Williamsport, Pa., has decided to make additions to its plant.

It is expected that the Mill Machinery Company will locate a plant at Saginaw, Mich.

The International Creosoting Company contemplates the erection of a plant at Beaumont, Tex.

Hibner & Hoover, of Dubois, Pa., are having an addition erected. They manufacture gas stoves.

The plant of the Lisbon Woolen Company at Lisbon, Ohio, which was recently burned, is to be rebuilt.

The E. P. Magann Air Brake Company, of Detroit, Mich., recently filed articles of incorporation.

G. P. Haskell and wife have arrived in the city from Columbus, Ohio, and will make there home here.

The Archibald Wheel Company will erect a factory at Damariscotta, Me., and put in the required machinery.

Meanney & Co. are to erect a power building in Buffalo, N. Y., and will purchase power transmission machinery.

The Berlin Iron Bridge Company, of East Berlin, Conn., are building a new boiler house

roof for the Coe Brass Manufacturing Company, at Ansonia, Conn.

The firm of Machen & Moore, of Laurens, S. C., is erecting a building in which roller mill machinery will be placed.

Caird & Hawksworth, of Helena, Mon., have built an addition to their foundry. They will also place new machinery.

Dietz, Schumacher & Boye, Cincinnati, Ohio, recently moved into their new factory on Queen City avenue, that city.

With its increasing business the Huntsville Electric Company, Huntsville, Ala., has been compelled to enlarge its plant.

Recently E. P. Reichhelm & Co., of 23 John street, New York, have admitted to the partnership Mr. Albert M. Leilman.

The United Alkali Company contemplates the erection of a new plant at Bay City, Mich. The main building will be 350x650 feet.

The F. A. Wilke Company, of Richmond, Ind., has been incorporated with a capital stock of $20,000, to manufacture portable kilns.

A two-story brick office and factory is to be built at 1615 Stiles street, Philadelphia, Pa., for Abronski Bros. by Contractor J. W. Kline.

Joseph Potter, of Pawtucket, R. I., is to erect a building for the manufacture of textile machinery, and will install necessary machinery and tools.

The contract for a new brick power house, to be built at the American Steel Casting Company's plant, Sharon, Pa., has been let to Walis & Carley.

The Pyott Foundry Company, Chicago, has been incorporated; capital, $10,000; incorporators, George W. Pyott, Albert E. Pyott, William C. Pyott.

Plans have been prepared by Alonzo G. Collins, Milwaukee, for an addition to the factory of the Hamilton Manufacturing Company at Two Rivers, Wis.

The new pumping station which will be erected by the water works department of Fort Wayne, Ind., on the land recently purchased will cost about $10,000.

Plans have been drawn and building will begin at once to enlarge the main portion of the local plant of the Diamond Match Factory, Oshkosh, Wis.

Mr. J. D. Griffin, of Memphis, Tenn., has lately been in Tuscaloosa, Ala., with a view of establishing a cotton mill in that city. Developments may follow later.

Doyle & Doak are estimating for a one-story power house, to be built for the Allison Manufacturing Company at Thirtieth and Chestnut streets, Philadelphia, Pa.

William Steele & Son have plans for a two-story L-shaped addition, 23x60 feet, to the morocco factory at Eighth and Kimball streets, Philadelphia, Pa., for Mitchell & Pierson.

The Niagara Lithograph Company, of Buffalo, N. Y., has purchased the property formerly occupied by the Frank Machine Company, and will refit it with improved lithograph machinery.

Messrs. C. W. & A. L. Adams have sold their interest in the firm of Bridgeford & Co., Louisville, Ky., to P. Galt Miller and George Ogle. The company will build a new foundry shortly.

The Kenyon-Rosing Machinery Company, Minneapolis, Minn., recently filed articles of incorporation. The incorporators are George P. Kenyon, O. C. Rosin, Paul Kenyon, all of Minneapolis. The capital stock is $25,000.

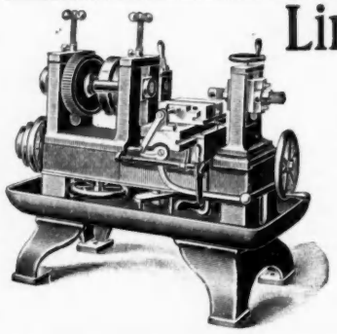
The Davis & Egan Machine Tool Company, of Cincinnati, Ohio, has taken an order for three 24-inch lathes, two 21-inch shapers and one large screw machine to go to Amsterdam, and to be used by the Dutch Government in the manufacture of guns.

Contracts have been awarded for the construction of the new Edison electric light plant on Charles street, Cincinnati, Ohio. The build-

See Page No. 44 for Special Ad. of

HENDEY MACHINE CO.,

TORRINGTON, CONN.



Lincoln Milling Machine

COLT'S MODEL, 1897.

With Foot Stock, Vise, Pan and Patent Adjustable Stop Mechanism that prevents breakage of mill teeth when the work is run up to the cutters.
Column Milling Machines in four sizes.
GRANT Single and Double Head Milling Machines, Vertical Spindle and Circular Milling Machines in variety, Milling Cutters, Milling Machine Vises and Centers.
Ask for the "Machinist's" Catalogue.

THE PRATT & WHITNEY COMPANY,

HARTFORD, CONN., U. S. A.

NEW YORK: 123 Liberty St. BOSTON: 144 Pearl St. CHICAGO: 42 South Clinton St. LONDON, England: Buck & Hickman, 280 Whitechapel Road. PARIS, France: Fenwick Freres & Co., 21 Rue Martel.

ENGINE and SPEED LATHES

IN VARIOUS LENGTHS—9 to 15 in. SWING.
Latest and Most Approved Designs. Workmanship, Material and Finish of the Highest Order.

SEBASTIAN LATHE COMPANY,

117 and 119 Culvert Street CINCINNATI, OHIO, U. S. A.

Agents: SELIG, SONNENTHAL & CO., London, Eng.; JOHN TRAGARDH & CO., Göteborg, Sweden; E. SONNENTHAL, JR., Berlin, Germany; R. S. STOKVIS & ZONEN, Rotterdam, Holland.

THE MECHANICAL ENGINEERING OF POWER PLANTS.

By FREDERIC REMSEN HUTTON, E.M., Ph.D.,
Professor of Mechanical Engineering in the School of Engineering of Columbia University.
8vo. Cloth. $5.00. 750 pages and 500 illustrations.

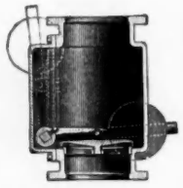
JOHN WILEY & SONS, 53 East Tenth Street, New York.

LIGHTNING CLUTCH DIE HOLDER.

For use in turrets of screw machines, screw plates, taps, dies, reamers, tap wrenches, bolt cutters, drilling machines, etc. Send for Catalogue.

WILEY & RUSSELL MFG. CO.,
Greenfield, Mass., U. S. A

Agents in London;
SELIG, SONNENTHAL & CO., 85 Queen Victoria Street.



Excelsior Straight-Way Back Pressure Valve.

This valve has no dash pots, springs, guides or complicated levers to get out of order. It is simple, reliable and well made. Never sticks, and can be relied upon at all times when using exhaust steam for heating; or when used as a relief, or free exhaust on a condensing plant, it has no equal. It is noiseless and free from any complicated attachments.

JENKINS BROTHERS, New York, Boston, Philadelphia, Chicago.

Do You Have Use for a **DRAWING TABLE?**

$5.00 will buy this one.

Firm, strong and durable. All parts detachable and shipped knocked down. Size of top, 20x30.
Is adjustable to any required angle, and from 28 to 45 inches in hight.

SPOONER & HALL, Selling Agents, Grand Rapids, Mich.

HUGH HILL CUT-OFF TOOL.

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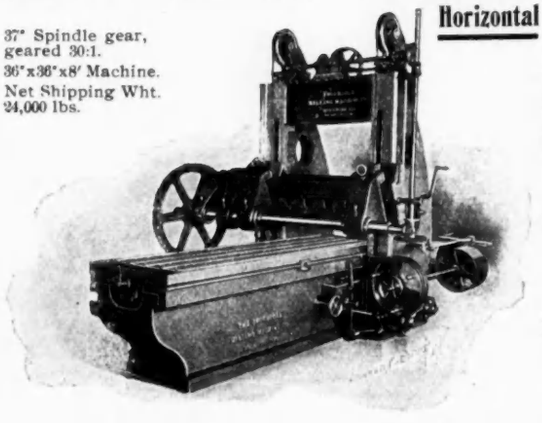

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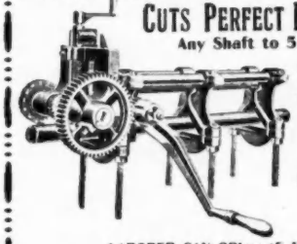

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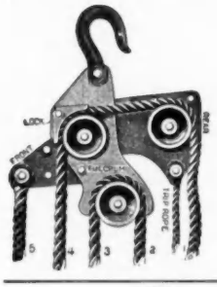

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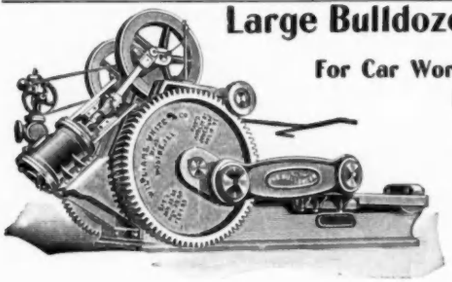

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Williams, White & Co.
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ing will be 250 by 107 feet, two stories high, and will cost $117,000. It will be of stone, brick and iron, with terra cotta trimmings.

Contracts have been let by Abel & Bach for the erection of a factory at Milwaukee, Wis., that is to be occupied by the Western Hardware & Manufacturing Company. The plant will consist of four buildings, and together with the site will cost $75,000.

The J. G. Brill Car Company, Philadelphia, Pa., intends to build a two-story brick and frame building, 186½ by 145½ feet, on Woodland avenue, between Sixtieth and Sixty-second streets, to be used for car building and packing cars for shipment. The operation will cost $12,000.

At Milwaukee, Wis., articles incorporating the Egan Manufacturing Company, with a capital of $25,000, have been filed. William J. Egan, Edward J. McDonough and Joseph Meyer are the incorporators. The company will manufacture machinery and electrical apparatus.

Ward-Leonard Electric Company, of Bronxville, N. Y., has been incorporated to manufacture rheostat, switches, electric heating devices, dynamo electric machinery, etc. Capital, $100,000, and directors, H. Ward Leonard, C. E. Carpenter, R. H. Mansfield, Jr., and H. P. Ball, of Bronxville, and H. A. Wise, of 44 Broad street, New York.

Articles of incorporation have been filed by the Ahwoga Manufacturing Company, Camden, N. J. The objects of the company are to manufacture matches and match-making machinery. The capital stock of the company is $1,000,000. The incorporators are E. M. Lockwood, of Oswego, N. Y.; George R. Moore, of Philadelphia, and Alexander Duer, of Camden.

A cotton yarn mill is to be erected at Norristown, Pa., for a stock company, from plans prepared by Architect Benjamin Gridley, of Garden street, Pawtucket, R. I. It will be brick and iron, measuring 100x210 feet, and will have all the modern improvements in special machinery, heating and steam fitting, electric lighting, office fixtures, etc.

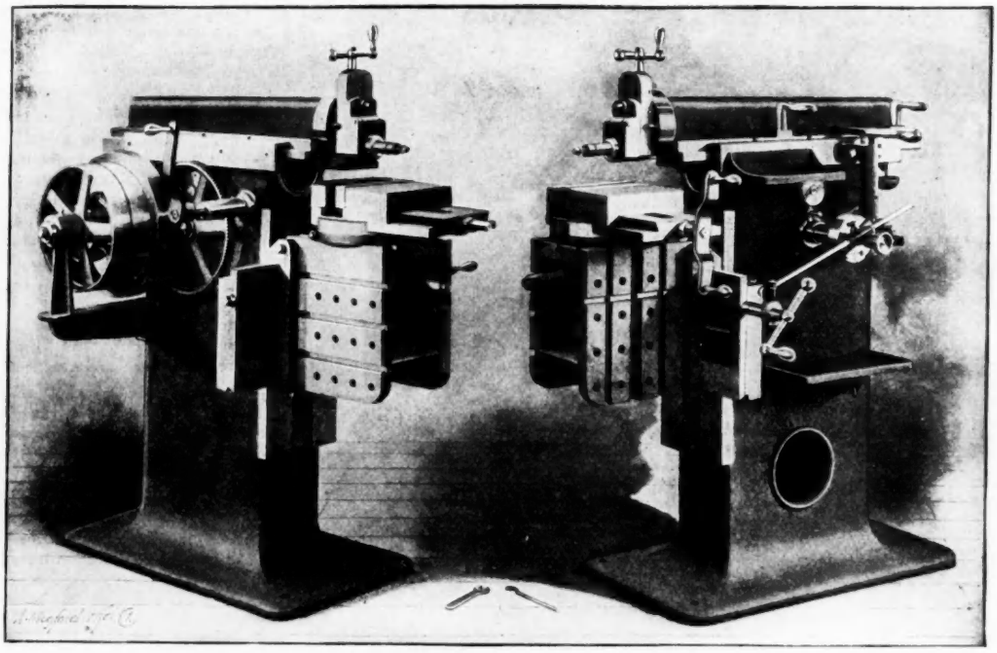
The foundry of the Hamilton (Ohio) Foundry & Machine Company was recently burned down. The company set to work and in just three weeks after the fire had occurred had erected a new foundry. This building is 100 by 200 feet and recently work was recommenced in it. The officers of the company are Geo. A. Rentschler, president; Julius Bunson, secretary, and Fred Thamy, superintendent.

Papers incorporating the Anchor Fence Company, of Jamestown, N. Y., have been filed with the Secretary of State. The new concern is capitalized at $30,000. Its objects are stated to be to manufacture and sell the Anchor fence and to acquire patents for the same. The directors for the first year are: C. M. Dow, J. B. Ross, W. M. Hoffer, J. T. Larmonth, F. W. Stevens, J. W. Stearns, W. P. Osmer, H. H. Cooper, C. Swanson, R. H. Johnson and Fred Simon, all of Jamestown.

Quinby & Broome, of No. 99 Nassau street, New York city, have prepared plans for a plant to be erected on Barren Island for the E. Frank Coe Company, of No. 133 Front street. It will consist of a two-story brick factory, 80x185, a one-story frame building, lined with fire brick, 41x106, and two condensing towers, 75 feet high, each 15x15, built of frame and brick, have asphaltic roofs, piling, fire brick, two boilers, pumps, machinery, etc. The total cost of buildings will be about $45,000.

An electrical manufacturing company has been organized in Sandy Hill, N. Y., to be known as the Warren-Medbury Company. It is a corporation with $25,000 capital, held by the following gentlemen: H. J. Medbury and E. D. Medbury, of Ballston; H. B. Warren, of Yonkers; Harry J. Tidmarsh, George Wait, William Wells, Lincoln Paris, Hon. C. R. Paris, John Galiagher and William Cunningham, of Sandy Hill. Articles of incorporation have been filed with the Secretary of State, and business will be begun at once.

15-inch Pillar Shaper.



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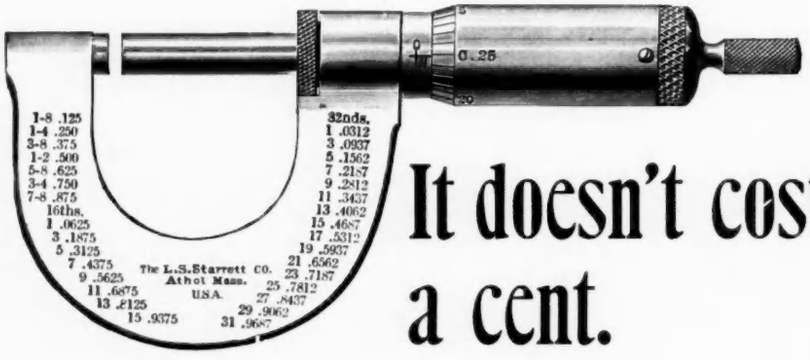

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for getting up a little club of subscribers —half hour's work— write to

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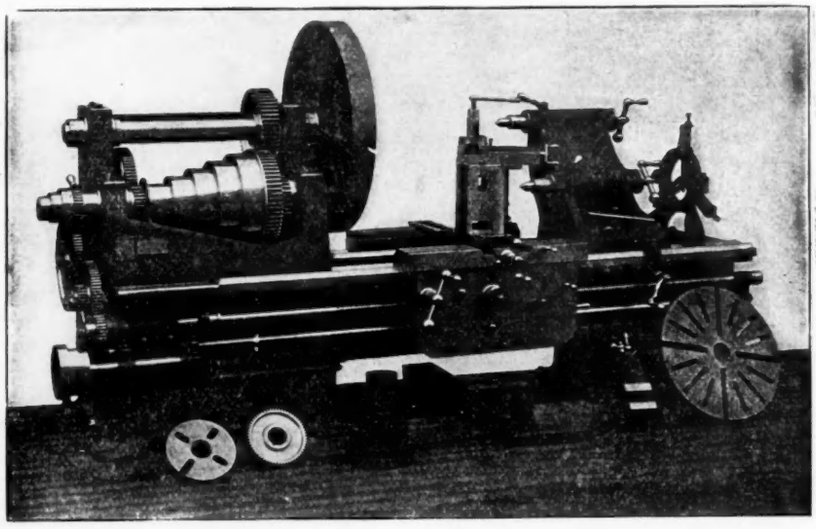

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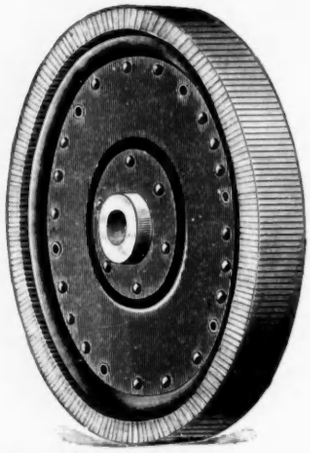
Have to study economy.



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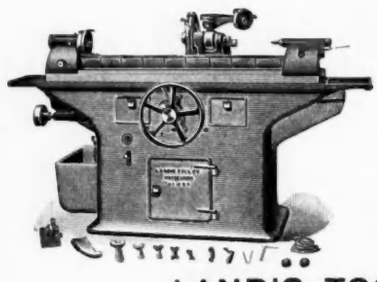

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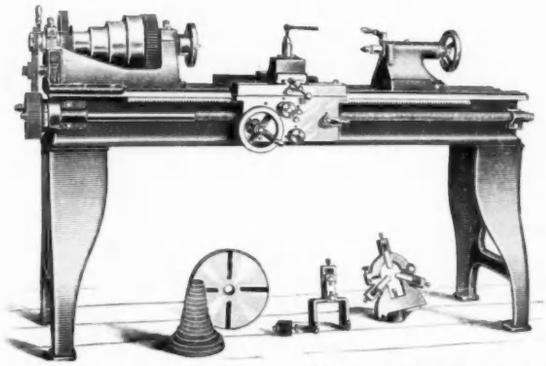

An Engine Lathe made from new patterns and guaranteed in every respect. This is a good, honest lathe, built for service, made to be depended upon at all times, and has some features rather better than some others. We should be pleased to take up this matter with you. Full description ready.

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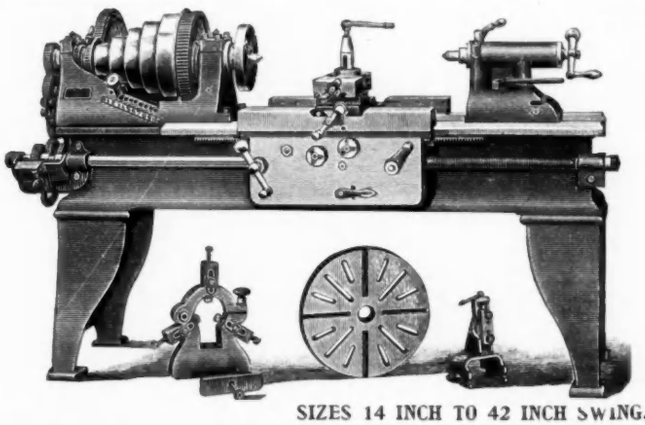

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You just slide the gear on the main-shaft, at the left, opposite the thread desired, as shown on the index plate; "press the button" into the hole shown by the hole index, and there you are! Any one of 40 threads; any one of 40 different feeds.

SIZES 14 INCH TO 42 INCH SWING. BEDS IN EVEN LENGTHS.

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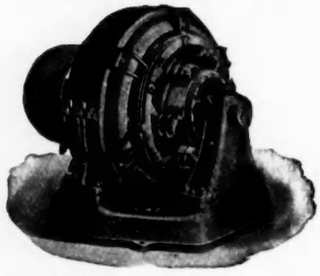

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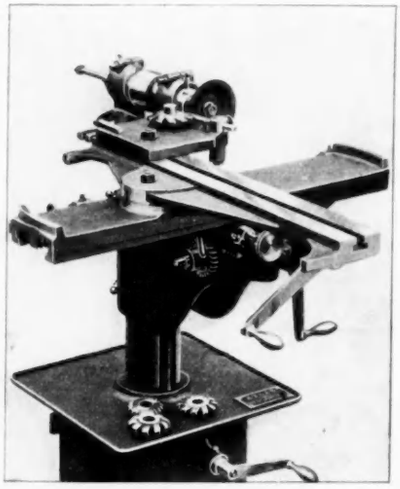

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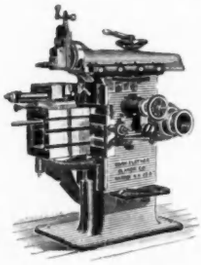

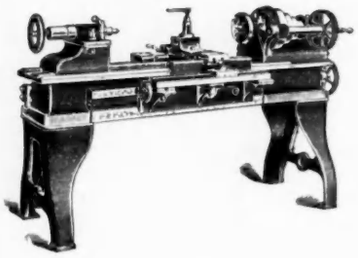

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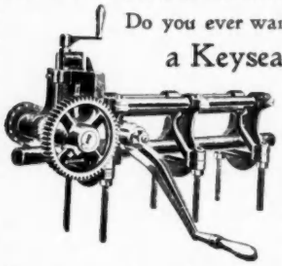

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Almost New Machine Tools

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1 Gleason Triple Geared Lathe, 72 in. x 52 ft.
1 " " " " 42 in. x 33½ ft.
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1 " " " 18 in "
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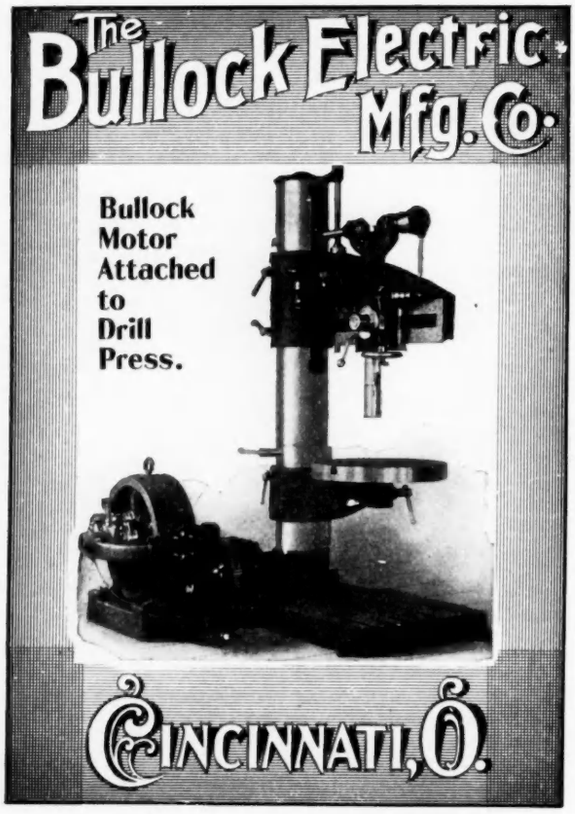

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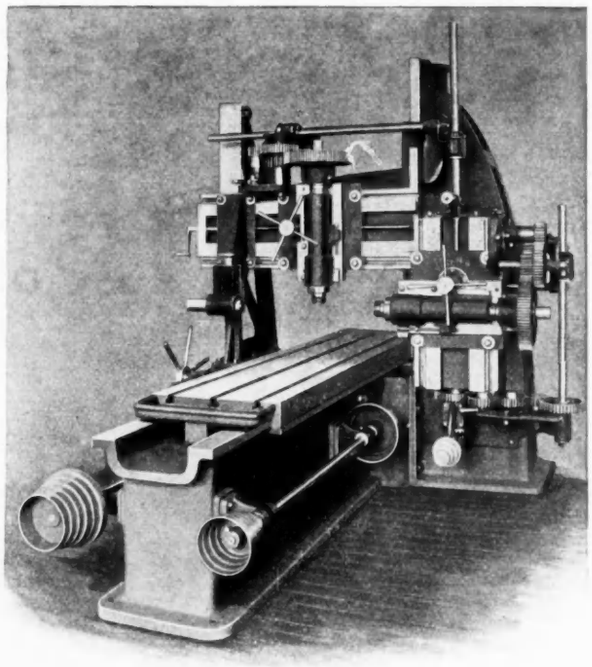

I fear that I am a little ahead of Modern Practice, but think it will catch up about the year 1900.

I am all ready for business, and by taking me now you will get just so much ahead of the other fellow.

I have capacity enough to take a piece 40 inches square. My Table is 24 inches wide and 8 feet long, Automatic Feed, Stop and Quick Power Movement in either direction.

I have two Spindles. Both are frequently used at the same time, and with them any kind of a milling cutter known can be used to advantage.

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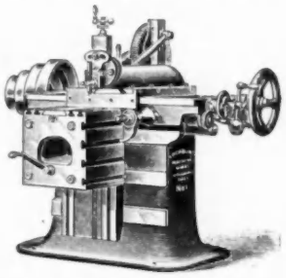
Our 34 years of progressive **MACHINE TOOL** building enables us to produce a line of fine Machines which will enable you to produce GOOD WORK and LOTS OF IT.



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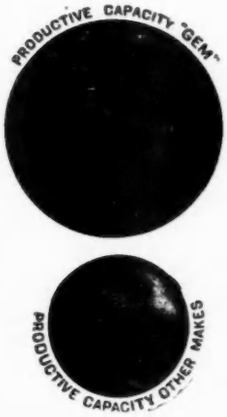

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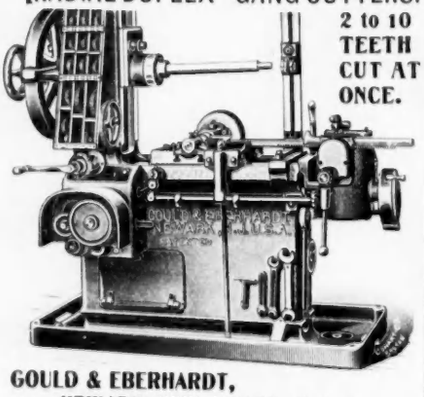

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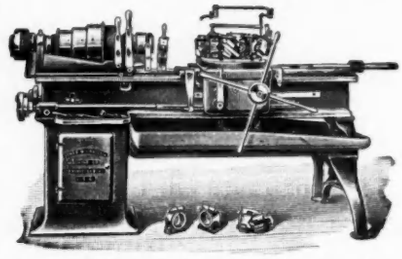

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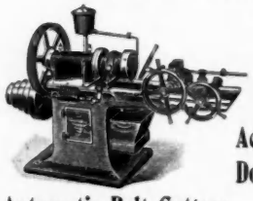

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